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H. W. WILEY, Chief of Bureau.

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## IDENTIFICATION OF FOOD COLORS.

A TENTATIVE REPORT ON THE SOLUBILITY AND EXTRACTION OF CERTAIN COLORS, AND THE COLOR REACTIONS OF DYED FIBER AND OF AQUEOUS AND SULPHURIC ACID SOLUTIONS.

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## INTRODUCTION.

The subject of food colors is so extensive, and so little comparatively has been accomplished in this field, that the reports made have been of necessity of a tentative nature, such for example as the work reported by W. G. Berry, in Circular 25 of this Bureau, in 1905, under the title "Coloring Matters for Food Stuffs and Methods for their Detection." That work, presented by the referee on colors in the Association of Official Agricultural Chemists, was supplemented by a subreport by Mr. Loomis in 1906, issued as Circular 35. This circular has proved of assistance to those doing pioneer work along these lines, having been reprinted in 1908 and 1909 with slight changes. The data presented in the present revision have been modified and extended in accordance with the results of more recent investigations, and an analytical scheme for the preliminary identification of colors added. The difficulties of this subject and the variations in the colors used preclude any marked degree of finality in such results, but the data are thought to be of special interest and usefulness to food chemists at this time.

Respectfully,

H. W. WILEY,  
*Chief of Bureau.*

Approved:

JAMES WILSON,

*Secretary of Agriculture.*

WASHINGTON, D. C., September 10, 1910.

## PLAN OF THE EXPERIMENTS.

The tables given in this report show the result of experimental work done on various coloring matters. Most of the coal-tar colors used were obtained direct from the manufacturers or agents, to whom acknowledgment is due. The names of these firms and the abbreviations under which they are designated in the descriptions of the colors in the tables are as follows:

- H. A. Metz & Co., agents for Meister, Lucius & Brüning (M. L. B.).
- Berlin Aniline Works (Berlin).
- American Aniline and Extract Company, agents for Brooke, Simpson & Spiller, Ltd., London, E. (B. S. S.).
- Continental Color and Chemical Company, agents for F. Bayer & Co. (By.) and Badische Anilin- und Soda-Fabrik (Bad.).
- Cassella Color Company (Cassella).
- Geisenheimer & Co., agents for K. Oehler (Oehler).
- Read, Holliday & Sons (R. H.).
- Schoellkopf, Hartford & Hanna Company (Sch.).
- W. F. Sykes & Co., agents for St. Denis Dye Stuff and Chemical Company (St. Denis), and for Coez, Langlois & Company (Coez) or (Sykes).
- Kalle & Co. (Kalle).
- Eimer & Amend (E. & A.).
- George Grübler & Co. (Grübler).

The revision of Tables I to IV consists chiefly in a rearrangement of the data and a consecutive numbering of the colors in a manner which permits of ready reference from one table to another and renders the information more readily accessible. While these tables do not by any means include all food colors, the greater part of those usually employed will be found. A thorough examination has been made of the colors used in this investigation and some important corrections have been made. The tables have also been extended somewhat and an analytical scheme for the preliminary identification of colors has been added (see page 62).

As has been pointed out by several workers on this subject, any scheme for the identification of colors in foodstuffs and allied substances is necessarily subject to constant revision on account of the vast number of colors, both natural and synthetic, which are already on the market, and the number of which is constantly being increased. However, in the author's experience, the number of colors used for that purpose commercially is quite limited, as the matter of cost and availability excludes many of the natural colors and the nature of each food product excludes dyes other than those of a certain color or chemical nature.

It is very essential for the identification of a coal-tar color, or any other coloring matter in foods, to obtain the color in as pure a state as possible. All colors used in the preparation of these tables were

supplied as pure colors, but tests have also been made to ascertain if they were mixtures of more than one color. This was found to be the case in a few instances.

### SOLUBILITY.

The results given for solubility in Table I are only approximate and were obtained by shaking an excess of the color with the various solvents named, filtering, if necessary, and evaporating to dryness, in order to determine the amount of color dissolved. The letters used to express the varying degrees of solubility are explained in connection with the table. Where the color of the solution is not given, it may be assumed to be practically the same as that of the aqueous solution.

The numbers in the last column of Table I are those of the corresponding colors in Green's translation of the fourth German edition of "A Systematic Survey of the Organic Coloring Matters," by Schultz and Julius.

### EXTRACTION WITH IMMISCIBLE SOLVENTS.

The determinations given in Table II were made as follows:

Twenty-five cubic centimeters of a 0.01 per cent solution of coal tar color, or about 0.10 per cent solution of natural coloring matters, were well shaken up with 25 cc of the immiscible solvent in a separating funnel. In the case of extraction with acetone the solution of color was first saturated with common salt to render the acetone insoluble. After separation into layers, the amount of color extracted was determined either by the relative depth of color in the two layers or by taking equal volumes of each layer and ascertaining the proportions by dyeing tests on plain or mordanted wool. The signs 0,  $>\frac{1}{2}$  (more than half), and  $<\frac{1}{2}$  (less than half) indicate the amount of color extracted from the aqueous solution. The color given underneath the above signs indicates the color of the immiscible solvent solution, unless otherwise specified. From 5 to 10 drops of concentrated hydrochloric acid or ammonium hydroxid (0.95 sp. gr.) were used to make the solutions acid or alkaline.

### COLOR REACTIONS OF DYED FIBER.

In the tests reported in Table III the wool was dyed with one-half per cent of coal-tar color in every case; in the case of natural coloring matters the amount used was about ten times greater. A piece of dyed zephyr yarn about 1 inch long was covered with 2 or 3 cc of the reagent in a small porcelain dish. Unless the color of the reagent became marked nothing is noted in the column marked "solution" in the table. The color reactions were observed three or four minutes after the addition of the reagent. The dyed fiber should be dry in making these tests to prevent charring of the fiber by the strong acids.

REACTION OF COLORS IN AQUEOUS SOLUTION AND WITH  
CONCENTRATED SULPHURIC ACID.

While similar tables have been prepared by other workers, considerable uncertainty arises in using them, and it has been the aim of the writer in preparing these tables to be somewhat more precise in the description of these reactions. As one means to this end, in Table IV the approximate strength of the color solution used (about 0.01 per cent) is indicated by the color of the solution in a test tube three-quarters of an inch in diameter. As before stated, the solutions of natural coloring matter are about ten times stronger than those of the coal-tar dyes, namely, 0.1 and 0.01 per cent, respectively. About 5 cc of color solution, 0.2 gram of zinc dust, and 10 drops of concentrated hydrochloric acid were used for the reduction test, and approximately 10 cc of color solution for the other reactions in aqueous solution.

The dry color test with concentrated sulphuric acid was conducted as follows:

About 0.01 gram of coal-tar color, or 0.05 gram of natural coloring matter, was dissolved by shaking with 5 cc of concentrated sulphuric acid in a test tube. The solution was diluted with water, 3 to 5 cc at a time, until the volume reached about 20 cc, then more rapidly with constant shaking, noting any changes in the appearance of the solution, until such change seemed merely to affect the depth of the color.

DISCUSSION OF DETAILS OF MANIPULATION.

Precautions to be observed in applying the Sostegni and Carpentieri method.

In the case of coal-tar dyes the well-known method of Sostegni and Carpentieri<sup>a</sup> is adapted:

If the color is in aqueous solution, slightly acid with hydrochloric acid, the wool can be heated in it directly or after diluting.

If in alcoholic solution the alcohol should first be driven off by evaporation.

If in a solid or semisolid substance, the color can generally be extracted by wool after dissolving or suspending the finely divided substance in water and slightly acidifying with hydrochloric acid.

In some cases, however, it is better to extract the finely divided and dried substance by warming with alcohol or water, made slightly alkaline with ammonia. The alcohol is then evaporated off, keeping up the volume with water, the aqueous solution is made slightly acid with hydrochloric acid and the color extracted by wool.

For heavy saccharine substances, such as confectionery, it is often best to evaporate as far as possible on the steam bath and then

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<sup>a</sup> U. S. Dept. Agr., Bureau of Chemistry Bul. 107, revised, p. 190

extract the color from the residue with strong alcohol; or the sugar may be wholly or in part removed by diluting and fermenting with yeast. In cereal products and in other cases, possibly, it is a good plan to make a preliminary extraction with ether. This removes interfering fat or oil and indicates the presence or absence of oil-soluble color.

The color is dyed on a piece of white zephyr yarn or nun's veiling, freed from dirt and grease by boiling with very dilute sodium hydroxid (0.1 per cent), in a solution slightly acid with hydrochloric acid. The wool is removed, well washed, and the color extracted therefrom by warming in very dilute ammonia. In most cases fifteen minutes' gentle boiling is sufficient. The wool is then removed, its color noted, and the solution made slightly acid with hydrochloric acid and the dyeing and extraction process repeated on a new piece of wool.

If the second piece of wool, after extracting the coal-tar color a second time with ammonium hydroxid as far as possible, is clean and shows no indication of the presence of vegetable color on the fiber, the alkaline solution of coal-tar color is sufficiently pure. Otherwise the process of dyeing and extraction must be repeated on a new piece of wool till the absence of vegetable color is indicated.

The color solution is then evaporated to dryness on the water bath, when there is obtained a residue of the dry color, on part of which the reaction with concentrated sulphuric acid may be tried and from which a neutral aqueous solution may be prepared for extraction and color tests.

This procedure applies only to acid coal-tar dyes; similarly, by reversing the process—that is, dyeing in neutral or slightly alkaline solution, and extracting the color from the fiber by a solution weakly acid with hydrochloric acid—basic coal-tar dyes can be isolated in a state of reasonable purity for identification. The solution of color may also be investigated by the spectroscope.<sup>a</sup>

#### EXAMINATION OF OILS AND FATS.

(1) Carry out the process for determination of unsaponifiable organic matter, and test for colors in the unsaponifiable matter.

(2) In case the oil or melted fat shows positive reaction by Geisler's fuller's earth test,<sup>b</sup> continue by treating 50 grams or more of the oil with 25 grams of fuller's earth, and after standing one hour, with frequent shaking, filter, wash earth free from oil with gasoline, and

<sup>a</sup> Formánek, Untersuchung und Nachweis organischer Farbstoffe auf spektroskopischem Wege.

<sup>b</sup> Zts. Nahr. Genussm., 1899. 2:150.

then extract color from fuller's earth with hot alcohol, and apply tests for identifying the color.

(3) Shake gasoline solution of colored oil or fat with very weak potassium hydroxid solution (Leed's method).

(4) Shake the oil or melted fat with boiling 90 per cent alcohol for several minutes. Cool with ice about one hour, then filter through a filter wet with alcohol. Reduce the volume of the alcohol solution about one-third on the water bath and decant or filter from any oil which separates on cooling. The color may be separated from this oil by the method under (1). Color tests may now be applied to the alcoholic solution of the color or to the dry color obtained by its evaporation. This alcoholic solution would, of course, also contain any free fatty acids, cholesterol, or phytosterol in the oil or fat.

#### DETECTION OF MIXED COLORS.

(1) Macroscopic or microscopic examination of dry color.

(2) One of the best ways for testing mechanically mixed, dry colors is by sprinkling the powdered color on the surface of sulphuric acid in a broad shallow dish, such as a petri culture dish, and noticing any difference in the colored spots formed. A similar method with water is commonly used, and it is recommended that this test be carried out as follows:

Fill a 500 cc Griffin beaker to the depth of about 4 inches with water, or in some cases preferably with dilute alcohol. On the surface sprinkle the powdered color. The streaks of color formed in the liquid as the particles fall to the bottom of the beaker will generally indicate plainly whether one or more colors are present.

(3) Capillarity test. (Allen, Commercial Organic Analysis, vol. 3, pt. 1, p. 478.)

(4) Fractional dyeing. (Allen, loc. cit., p. 479.)

(5) Treatment of dry color with various solvents, or extraction of aqueous solution with immiscible solvents, and making comparative dyeing tests with extracted color and residual color in aqueous solution.

#### NATURAL COLORING MATTERS.

It is generally very difficult to isolate natural coloring matters in a state of purity, and the task of identifying them with certainty is still more complicated. They can best be separated by extraction with an immiscible solvent, or by dyeing on wool, mordanted with alum, tin, or chromium. Special tests have also been devised for the more common natural coloring matters, which can be found in any standard work on food analysis. Caramel is extensively used as a coloring matter in food products, and its detection is important, especially in vanilla extracts and liquors. In case of a brown-colored

substance, which gives no reaction for acid or basic coal-tar dye, tests should always be made for caramel. It is best not to depend on any one procedure but to apply several of the many suggested for this purpose. The following have been found most useful:

Marsh's test as modified by Tolman, depending on the insolubility of caramel color in amyl alcohol. (Bul. 122, Bureau of Chemistry, p. 206.)

The fuller's earth test is very useful as a supplementary test, but it is first necessary for the analyst to experiment with the particular lot of fuller's earth used. For instance, in the case of vanilla extracts preliminary experiments should be made with known samples of pure extracts and samples colored wholly or partly with caramel.

Phenylhydrazine test (for extracts). (Bul. 65, Bureau of Chemistry, p. 71.)

Paraldehyde test (for distilled liquors). (Bul. 107, Bureau of Chemistry, p. 101.)

To detect mineral pigments or to identify color lakes, it is necessary to examine the incinerated substance for heavy metals, chiefly aluminum, tin, and iron.

#### METHODS OF MORDANTING WOOL.

*Mordanting wool with alum.*—In 500 cc of water dissolve 1 gram of crystallized aluminum sulphate and 1.2 grams of cream of tartar. Stir 10 grams of fat-free wool in the solution for one-half hour, let stand two to three hours, wring and dry at room temperature.

*Mordanting wool with tin.*—In 500 cc of water dissolve 0.8 gram of tin crystals, and 0.4 grams of oxalic acid. Boil 10 grams of fat-free wool one and one-half hours in this solution.

*Mordanting wool with bichromate of potash.*—Place 10 grams of wool in 500 cc of water and heat to boiling, then add 0.2 gram of potassium bichromate, 0.35 gram of cream of tartar, and 0.1 cc of concentrated sulphuric acid, and boil one and one-half hours. Dry at low temperature and keep mordanted wool from exposure to light.

[Cir. 63]

TABLE I.—SOLUBILITY OF COLORS, WITH COLOR OF SOLUTION.

[S = readily soluble; s = fairly soluble; F = slightly soluble; f = almost insoluble; I = insoluble.]

## COAL-TAR COLORS.

| No. | Name of color.             | Water.           | Ethyl alcohol (90.5 per cent by weight). | Methyl alcohol (97 per cent by weight). | Ethyl ether, U. S. P. | Ethyl acetate. | Acetone. | Amyl alcohol. | Glacial acetic acid (99 per cent). | Ammonia water.   | Schultz and Julius numbers. |
|-----|----------------------------|------------------|--|---|-----------------------|----------------|----------|---------------|------------------------------------|------------------|-----------------------------|
| 1   | Ponceau red (Grübler).     | S<br>Crimson.    | F<br>Orange.                             | S<br>Orange.                            | I                     | I              | I        | I             | F<br>Red orange.                   | .....            | .....                       |
| 2   | Ponceau 6 R (M. I. B.).    | S<br>Crimson.    | I  | S<br>Deep cherry.                       | I                     | I              | I        | I             | I                                  | .....            | 108                         |
| 3   | Scarlet 6 R (M. I. B.).    | S<br>Cherry red. | I  | S<br>Crimson.                           | I                     | I              | I        | I             | I                                  | .....            | 108                         |
| 4   | New cochineal (Berlin).    | S<br>Orange red. | F<br>Cherry.                             | S<br>Cherry.                            | I                     | I              | I        | I             | I                                  | .....            | 106                         |
| 5   | Cochineal red A (Bad.).    | S<br>Orange red. | S<br>Orange red.                         | S<br>Cherry red.                        | I                     | I              | I        | I             | F<br>Orange red.                   | .....            | 106                         |
| 6   | Ponceau 4 R B (Berlin).    | S<br>Crimson.    | S  | S<br>Red orange.                        | I                     | I              | I        | I             | F<br>Pink.                         | S                | .....                       |
| 7   | Crocein scarlet 3 B (By.). | S<br>Cherry.     | S  | S<br>Red orange.                        | I                     | I              | I        | I             | F<br>Red orange; ppt.              | .....            | 160                         |
| 8   | Crocein scarlet 7 B (By.). | S<br>Crimson.    | S  | S<br>Deep cherry.                       | I                     | I              | I        | I             | F<br>Magenta.                      | S<br>Orange red. | .....                       |
| 9   | Fast ponceau B (Bad.).     | S<br>Orange red. | S<br>Red orange.                         | S                                       | I                     | I              | I        | I             | F<br>Pale magenta.                 | F<br>Brown.      | 163                         |

TABLE I.—*Solubility of colors, with color of solution—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.                                      | Water.           | Ethyl alcohol<br>(90.5 per cent<br>by weight). | Methyl alcohol<br>(97 per cent<br>by weight). | Ethyl ether,<br>U. S. P. | Ethyl acetate. | Acetone. | Amyl alcohol. | Glacial acetic<br>acid (99 per<br>cent). | Ammonia<br>water. | Schultz and<br>Julius num-<br>bers. |
|-----|---|------------------|--|---|--------------------------|----------------|----------|---------------|--|-------------------|-------------------------------------|
| 10  | Biebrich fast scarlet O<br>(Kalle).                 | S<br>Orange red. | F<br>Orange.                                   | S<br>Scarlet.                                 | I                        | F<br>Orange.   | Pink.    | I             | Wine red.                                | .....             | 159                                 |
| 11  | Biebrich erioein scarlet<br>O (Kalle).              | S<br>Orange red. | F<br>Orange red.                               | S<br>Scarlet.                                 | I                        | I              | Orange.  | I             | F<br>Crimson.                            | .....             | 160                                 |
| 12  | Biebrich erioein scarlet<br>OO (Kalle).             | S<br>Scarlet.    | F<br>Scarlet.                                  | F<br>Scarlet.                                 | I                        | I              | Orange.  | I             | F<br>Crimson.                            | .....             | 169                                 |
| 13  | Biebrich brilliant cro-<br>cein scarlet O (Kalle).  | S<br>Scarlet.    | F<br>Orange red.                               | S<br>Scarlet.                                 | I                        | I              | Orange.  | I             | F<br>Scarlet.                            | .....             | 146                                 |
| 14  | Biebrich brilliant cro-<br>cein scarlet ON (Kalle). | S<br>Scarlet.    | F<br>Orange red.                               | S<br>Scarlet.                                 | I                        | I              | Orange.  | I             | F<br>Scarlet.                            | .....             | 146                                 |
| 15  | Scarlet RD (R. H.).<br>(Mixture.)                   | S<br>Orange red. | S<br>Orange red.                               | S<br>Orange red.                              | I                        | I              | F        | F             | S  | .....             | .....                               |
| 16  | Ponceau 2 R (Sch.).                                 | S<br>Cherry red. | F  | S   | I                        | I              | I        | I             | F<br>Orange red.                         | .....             | 55                                  |
| 17  | Ponceau 3 R (Sch.).                                 | S<br>Cherry red. | F  | S   | I                        | I              | I        | I             | F  | .....             | 56                                  |
| 18  | Brilliant cochineal 2 R<br>(Cassella).              | S<br>Orange red. | S  | S   | I                        | I              | I        | I             | F<br>Orange.                             | .....             | 53                                  |

TABLE I.—*Solubility of colors, with color of solution—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.                    | Water. | Ethyl alcohol (90 $\frac{1}{2}$ per cent by weight). | Methyl alcohol (97 per cent by weight). | Ethyl ether, U.S. P. | Ethyl acetate.   | Acetone.         | Amyl alcohol.      | Glacial acetic acid (99 per cent). | Ammonia water. | Schultz and Julius numbers. |
|-----|-----------------------------------|--------|--|---|----------------------|------------------|------------------|--------------------|------------------------------------|----------------|-----------------------------|
| 19  | Fast red A (Bad.).                | S      | Orange red.  | S                                       | I                    | S                | S                | S                  | S                                  | .....          | 102                         |
| 20  | Fast red B (Bad.).                | S      | Deep crimson, Deep orange red.                       | S                                       | I                    | f<br>Orange.     | S<br>Orange red. | f<br>Pink.         | S<br>Crimson.                      | .....          | 65                          |
| 21  | Bordeaux B (Berlin).              | S      | Crimson.   | S                                       | I                    | I                | I                | F                  | S                                  | .....          | 65                          |
| 22  | Fast red C (Bad.).                | S      | Crimson.   | S                                       | Orange red.          | I                | f<br>Pink.       | f<br>Orange red.   | S<br>Crimson.                      | .....          | 103                         |
| 23  | Azo-rubin (Sch.).                 | S      | Crimson.   | F                                       | S                    | I                | I                | f<br>Pale magenta. | F<br>Cherry.                       | .....          | 103                         |
| 24  | Carmosin B (R. H.).               | S      | Crimson.   | F                                       | S                    | I                | f<br>Red orange. | F<br>Brown orange. | F                                  | .....          | 103                         |
| 25  | Fast red D (Bad.).                | S      | Crimson.   | S                                       | I                    | S<br>Orange red. | S<br>Orange red. | Orange red.        | S<br>Crimson.                      | .....          | .....                       |
| 26  | Amaranth B (Cassella). (Mixture.) | S      | Deep crimson.  | f<br>Pink.                              | Wine color.          | I                | I                | I                  | f<br>Orange brown.                 | .....          | .....                       |
| 27  | Amaranth (Sch.).                  | S      | Crimson.   | I                                       | S                    | I                | I                | I                  | f<br>Pink.                         | .....          | 107                         |

TABLE I.—*Solubility of colors, with color of solution—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.                      | Water.                  | Ethyl alcohol (90.5 per cent by weight). | Methyl alcohol (97 per cent by weight). | Ethyl ether, U. S. P.   | Ethyl acetate.          | Acetone. | Amyl alcohol.           | Glacial acetic acid (99 per cent). | Ammonia water. | Schultz and Julius numbers. |
|-----|-------------------------------------|-------------------------|--|---|-------------------------|-------------------------|----------|-------------------------|------------------------------------|----------------|-----------------------------|
| 28  | Archil substitute (R. H.).          | f<br>Red orange.        | S<br>Crimson.                            | I<br>Crimson.                           |                         | F<br>Crimson.           |          | F<br>Crimson.           | S<br>Wine red.                     | .....          | 28                          |
| 29  | Archil substitute 3 VN (St. Denis). | S<br>Magenta.           | S<br>Crimson.                            | S<br>Crimson.                           | F<br>Orange red.        |                         |          | F<br>Crimson.           |                                    | .....          | 29                          |
| 30  | Lanafuchsin 6 B (Cassella).         | S<br>Deep crimson.      | S<br>Crimson.                            | S<br>Crimson.                           | I<br>I                  |                         | F<br>I   |                         | Purple.                            | .....          | .....                       |
| 31  | Magenta.                            | S<br>Crimson.           | S<br>Crimson.                            | S<br>Lilac.                             |                         |                         |          | S<br>Crimson.           | S<br>S                             | .....          | 448                         |
| 32  | Acid magenta (Bad.).                | S<br>Deep crimson.      | S<br>Crimson.                            | S<br>Cherry; fluor.                     | I<br>I                  |                         | F<br>I   | Violet.                 | Pale magenta.                      | Pale magenta.  | 462                         |
| 33  | Safranin (B. S. S.).                | S<br>Crimson.           | S<br>Cherry.                             | S<br>Cherry; slight fluor.              | I<br>I                  |                         | F<br>I   | Cherry; fluor.          | Cherry; fluor.                     | S<br>.....     | 584                         |
| 34  | Benzopurpurin (Grübler).            | S<br>Cherry red.        | S<br>Cherry.                             | S<br>Cherry.                            |                         | I<br>Orange.            | F<br>I   |                         | I<br>I                             | .....          | 277 or 278                  |
| 35  | Congo red (Grübler).                | S<br>Cherry red.        | S<br>Deep orange.                        | S<br>Deep orange.                       | I<br>I                  |                         | I<br>I   | I<br>I                  | I<br>I                             | .....          | 240                         |
| 36  | Eosin (Grübler). (Mixture.)         | S<br>Cherry red; fluor. | S<br>Red orange; strong fluor.           | S<br>Red orange; strong fluor.          | I<br>Red orange; fluor. | F<br>Red orange; fluor. |          | S<br>Red orange; fluor. | S<br>Yellow.                       | .....          | .....                       |

TABLE I.—*Solubility of colors, with color of solution—Continued.*

## COAL-TAR COLORS—Continued.

| Cir. 63<br>No. | Name of color.          | Water.                            | Ethyl alcohol<br>(90.5 per cent<br>by weight). | Methyl alcohol<br>(97 per cent<br>by weight). | Ethyl ether,<br>U. S. P.       | Ethyl acetate.                              | Acetone.                             | Amyl alcohol.                    | Glacial acetic<br>acid (99 per<br>cent). | Ammonia<br>water. | Schultz and<br>Julius num-<br>bers. |
|----------------|-------------------------|-----------------------------------|--|---|--------------------------------|---|--------------------------------------|----------------------------------|--|-------------------|-------------------------------------|
| 37             | Eosin A (Bad.).         | S<br>Orange red;<br>green fluor.  | S<br>Orange;<br>green fluor.                   | I   | F<br>Pink; green<br>fluor.     | F<br>Green fluor.                           | S<br>Green fluor.                    | S<br>Orange.                     | .....                                    | .....             | 512                                 |
| 38             | Azo-eosin (By.).        | S<br>Scarlet.                     | S<br>Orange red.                               | I   | F<br>Orange red.               | I   | Scarlet.                             | F<br>Orange red;<br>green fluor. | .....                                    | .....             | 71                                  |
| 39             | Phloxin (Bad.).         | S<br>Orange; green<br>fluor.      | S<br>Orange red;<br>yellow fluor.              | I   | F<br>Pink.                     | S<br>Pink; yellow<br>fluor.                 | S<br>Yellow fluor.                   | S<br>Orange red;                 | .....                                    | .....             | 521 and 518                         |
| 40             | Rose bengal (Bad.).     | S<br>Orange red.                  | S<br>Light crimson.                            | I   | F<br>Pink.                     | S<br>Light crimson;<br>yellow fluor.        | S<br>Light crimson;<br>yellow fluor. | S<br>Crimson.                    | S<br>Orange.                             | .....             | 520 and 523                         |
| 41             | Rhodanin (Bad.).        | S<br>Light crimson.               | S<br>Deep pink;<br>yellow fluor.               | I   | F<br>Light magenta.            | S<br>Slight fluor.                          | S<br>Yellow fluor.                   | S<br>Yellow fluor.               | S<br>Deep pink;<br>yellow fluor.         | .....             | 504                                 |
| 42             | Pink M (R. H.).         | S<br>Light crimson;<br>fluor.     | S<br>S   | S<br>S  | F<br>Pale magenta.             | S<br>Cherry; fluor.                         | S<br>Cherry; fluor.                  | S<br>Cherry; fluor.              | S<br>Cherry; fluor.                      | .....             | 504                                 |
| 43             | Fast pink B (Sch.).     | S<br>Cherry red;<br>yellow fluor. | S<br>Yellow fluor.                             | S<br>Fluor.                                   | F<br>Fluor.                    | S<br>Fluor.                                 | S<br>Fluor.                          | S<br>Fluor.                      | S<br>Fluor.                              | .....             | 504                                 |
| 44             | Erythrosin (certified). | S<br>Orange red.                  | S<br>Red orange;<br>slight greenish<br>fluor.  | I   | S<br>Same as<br>ethyl alcohol. | S<br>Red orange;<br>strong orange<br>fluor. | S<br>Red orange.                     | S<br>Yellow.                     | S<br>Orange red.                         | S<br>Orange red.  | 617                                 |

TABLE I.—*Solubility of colors, with color of solution—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.                    | Water.             | Ethyl alcohol (90.5 per cent by weight). | Methyl alcohol (97 per cent by weight). | Ethyl ether, U. S. P. | Ethyl acetate. | Acetone.       | Amyl alcohol. | Glacial acetic acid (99 per cent). | Ammonia water. | Schultz and Julius numbers. |    |
|-----|-----------------------------------|--------------------|--|---|-----------------------|----------------|----------------|---------------|------------------------------------|----------------|-----------------------------|----|
| 45  | Tropeolin O (Cassella).           | S<br>Orange.       | F  | I                                       | I<br>Yellow.          | F              | F              | F             | S                                  | .....          | 84                          |    |
| 46  | Tropeolin OO (Cassella).          | S<br>Orange.       | S  | S                                       | I                     | F              | Orange yellow. | F             | Wine red.                          | .....          | 88                          |    |
| 47  | Orange IV (R. H.).                | F<br>Orange.       | S  | S                                       | f<br>Yellow.          | F              | S              | F             | Orange brown.                      | .....          | 88                          |    |
| 48  | Methyl orange (Grißbier).         | S<br>Orange.       | S  | S                                       | I                     | F              | F<br>Yellow.   | F             | f<br>Light brown.                  | .....          | 87                          |    |
| 49  | Orange extra (Cassella).          | S<br>Red orange.   | S<br>Orange red.                         | F                                       | I                     | f<br>Orange.   | F              | F             | F                                  | S              | .....                       | 86 |
| 50  | Orange II (St. Denis).            | S<br>Orange red.   | S<br>Orange.                             | S<br>Orange.                            | I                     | F<br>Orange.   | F<br>Orange.   | F             | S<br>Orange.                       | .....          | 86(?)                       |    |
| 51  | Orange II (By.).                  | S<br>Red orange.   | F  | S                                       | I                     | I              | f<br>Orange.   | F             | F                                  | .....          | 86                          |    |
| 52  | Tyemond orange (R. H.) (Mixture). | S<br>Orange brown. | F<br>Orange.                             | S<br>Red.                               | I                     | I              | F<br>Orange.   | f<br>Orange.  | S<br>Red orange.                   | .....          | .....                       |    |
| 53  | Crocein orange Y (Sch.).          | S<br>Orange.       | F  | S                                       | I                     | f              | F              | F             | F                                  | .....          | 43                          |    |
| 54  | Orange I (certified).             | S<br>Red orange.   | S<br>Orange.                             | f                                       | s                     | F              | F              | S             | S                                  | Crimson.       | 85                          |    |

TABLE I.—*Solubility of colors, with color of solution*—Continued.

COAL-TAR COLORS—Continued.

| [Cir. 63] | No.                            | Name of color.      | Water.                   | Ethyl alcohol (30.5 per cent by weight). | Methyl alcohol (97 per cent by weight). | Ethyl ether, U. S. P. | Ethyl acetate. | Acetone. | Amyl alcohol. | Glacial acetic acid (99 per cent). | Ammonia water. | Schultz and Julius numbers. |
|-----------|--------------------------------|---------------------|--------------------------|--|---|-----------------------|----------------|----------|---------------|------------------------------------|----------------|-----------------------------|
| 55        | Crocein orange G (By.).        | S<br>Orange.        | S                        | S  | I                                       | F                     | F              | F        | F             | F                                  | .....          | 13                          |
| 56        | Ponceau 4 GB (Berlin).         | S<br>Orange red.    | S<br>Orange yel-<br>low. | F<br>Orange yel-<br>low.                 | F<br>Orange yel-<br>low.                | I                     | F              | F        | F             | S                                  | .....          | 13                          |
| 57        | Orange G (Berlin).             | S<br>Orange.        | F<br>Orange red.         | F<br>Orange red.                         | I                                       | I                     | I              | I        | I             | S                                  | .....          | 14                          |
| 58        | Orange G (R. H.).              | S<br>Red orange.    | S<br>Orange.             | S<br>Orange red.                         | I                                       | I                     | I              | F        | F             | S                                  | .....          | 86                          |
| 59        | Orange GG crystals (Cassella). | S<br>Orange.        | F<br>Yellow.             | S<br>Yellow.                             | I                                       | I                     | I              | I        | I             | S                                  | .....          | 14                          |
| 60        | Auramine.                      | S<br>Yellow.        | S                        | S  | I                                       | S                     | S              | S        | S             | S                                  | .....          | 425 or 426                  |
| 61        | Naphthol yellow (Bad.).        | S<br>Yellow.        | F<br>Yellow.             | S  | I                                       | I                     | F              | F        | I             | I                                  | .....          | 4                           |
| 62        | Yellow YM (R. H.).             | S<br>Orange.        | F<br>Yellow.             | S  | I                                       | I                     | F              | F        | I             | Yellow.                            | .....          | 4                           |
| 63        | Naphthol yellow (Grindler).    | F<br>Yellow.        | S                        | S  | S or F<br>Yellow.                       | S                     | S              | S        | S             | S                                  | .....          | .....                       |
| 64        | Martius yellow.                | F<br>Yellow.        | S                        | S  | S                                       | S                     | S              | S        | S             | Pale yellow.                       | S              | 3                           |
| 65        | Pierle acid.                   | F<br>Yellow.        | S                        | S  | S                                       | S                     | S              | I        | I             | Pale yellow.                       | S              | 1                           |
| 66        | Chrysanth.                     | F<br>Orange yellow. | F<br>Orange.             | S<br>Orange.                             | I                                       | I                     | F              | I        | I             | I                                  | Orange red.    | 220 or 260                  |

TABLE I.—*Solubility of colors, with color of solution*—Continued.

## COAL-TAR COLORS—Continued.

| No. | Name of color.                           | Water. | Ethyl alcohol (90.5 per cent by weight). | Methyl alcohol (97 per cent by weight). | Ethyl ether, U. S. P. | Ethyl acetate. | Acetone. | Amyl alcohol. | Glacial acetic acid (99 per cent). | Ammonia water. | Schultz and Julius numbers. |
|-----|--|--------|--|---|-----------------------|----------------|----------|---------------|------------------------------------|----------------|-----------------------------|
| 67  | Fast yellow (Bad.).                      | S      | F  | S                                       | F                     | F              | Yellow.  | f             | F                                  | .....          | 8                           |
| 68  | Wool yellow <sup>T</sup> extra (Sch.).   | S      | F  | S                                       | I                     | I              | I        | I             | Orange red.                        | .....          | 94                          |
| 69  | Tartrazin (Bad.).                        | S      | F  | F                                       | I                     | I              | I        | I             | f                                  | .....          | 94                          |
| 70  | Melanil yellow (Oehler).                 | S      | S  | S                                       | F                     | S              | F        | S             | .....                              | 95             | 95                          |
| 71  | Brilliant yellow S (Sch.).               | S      | S  | Orange.                                 | Yellow.               | S              | Yellow.  | S             | Orange brown.                      | .....          | 89                          |
| 72  | "Chinolin yellow," (R. II.) <sup>6</sup> | S      | F  | S                                       | I                     | I              | I        | I             | F                                  | Yellow.        | 667 (?)                     |
| 73  | Chrysoidin (Grübler).                    | S      | S  | S                                       | f                     | S              | F        | S             | .....                              | .....          | 18 (?)                      |
| 74  | Sudan I (prepared by author).            | I      | S  | Orange.                                 | Orange.               | S              | S        | S             | Red orange.                        | .....          | 11                          |
| 75  | Sudan brown (Berlin).                    | I      | S  | Brown.                                  | S                     | S              | S        | S             | Red brown.                         | .....          | 59                          |
| 76  | Sudan G (prepared by author).            | f      | S  | Orange red.                             | Orange red.           | S              | S        | S             | Orange red.                        | .....          | 10                          |

<sup>a</sup> Manufacturer's term; undoubtedly same as "quinolin."

TABLE I.—*Solubility of colors, with color of solution—Continued.*

## COAL-TAR COLORS—Continued.

| [Cir. 63] | Name of color.                  | Water.              | Ethyl alcohol (90.5 per cent by weight). | Ethyl ether, U. S. P. | Ethyl acetate. | Acetone. | Amyl alcohol. | Glacial acetic acid (99 per cent). | Ammonia water. | Schultz and Julius numbers. |
|-----------|---------------------------------|---------------------|--|-----------------------|----------------|----------|---------------|------------------------------------|----------------|-----------------------------|
| 77        | Malachite green (Berlin).       | S<br>Greenish bluc. | S  | Pale blue.            | S              | S        | Bluish green. | S                                  | .....          | 427                         |
| 78        | Ethyl green (Berlin).           | S<br>Bluish green.  | S  | I                     | F              | S        | Bluish green. | S                                  | .....          | .....                       |
| 78½       | Sudan III (prepared by author). | I<br>Red orange.    | S  | S<br>Orange red.      | S              | S        | Red orange.   | S<br>Orange red.                   | .....          | 143                         |
| 79        | Acid green 780 (Cassella).      | S<br>Green.         | S  | I                     | I              | I        | F             | F                                  | .....          | 435                         |
| 80        | Aeld green OO (Seh.).           | S<br>Blue green.    | S  | S                     | I              | I        | I             | F                                  | .....          | 435                         |
| 81        | Cyanole green 6 G (Cassella).   | S<br>Bluish green.  | S<br>Blue.                               | S<br>Blue.            | I              | I        | S<br>Blue.    | S                                  | .....          | .....                       |
| 82        | Naphthol green B (Cassella).    | S<br>Green.         | I  | S                     | I              | I        | I             | I                                  | .....          | 398                         |
| 83        | Azo blue (By.).                 | S<br>Deep violet.   | Magenta.                                 | F                     | Crimson.       | I        | Pink.         | I                                  | F<br>Magenta.  | 287                         |
| 84        | Cyanole FF (Cassella).          | S<br>Deep purple.   | S  | S                     | I              | I        | Blue.         | F<br>Blue.                         | S              | 439                         |

TABLE I.—*Solubility of colors, with color of solution—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.                    | Water.             | Ethyl alcohol (90.5 per cent by weight). | Methyl alcohol (97 per cent by weight). | Ethyl ether, U.S. P. | Ethyl acetate.     | Acetone.     | Amyl alcohol. | Glacial acetic acid (99 per cent). | Ammonia water.   | Schultz and Julius numbers. |
|-----|-----------------------------------|--------------------|--|---|----------------------|--------------------|--------------|---------------|------------------------------------|------------------|-----------------------------|
| 85  | Methylene blue (Bad.)             | S<br>Deep blue.    | S  | I                                       | f                    | F                  | F            | F             | S                                  | .....            | 650                         |
| 86  | Tetracyanole SF (Cassella).       | S<br>Blue.         | S  | I                                       | F                    | F                  | F            | F             | S                                  | .....            | 440                         |
| 87  | Methyl-violet DB (Sch.).          | S<br>Violet.       | S  | S                                       | F<br>Violet.         | S                  | S            | S             | S                                  | .....            | 451                         |
| 88  | Methylene violet 2 BX (Berlin).   | S<br>Deep violet.  | S  | S                                       | f<br>Violet.         | s                  | S            | S             | S                                  | .....            | 585                         |
| 89  | Indigo disulpho acid (certified). | S<br>Dark blue.    | F<br>Blue.                               | S<br>Dark blue.                         | I                    | I                  | I            | I             | S<br>Violet blue.                  | S<br>Dark green. | 692                         |
| 90  | Bismarck brown extra (Berlin).    | S<br>Orange brown. | S  | S                                       | I                    | F<br>Brown.        | f<br>Yellow. | Brown.        | f<br>Brown yellow.                 | .....            | 197                         |
| 91  | Fast brown G (Berlin).            | S<br>Crimson.      | S  | S                                       | I                    | F<br>Orange brown. | f            | I             | F                                  | .....            | 138                         |

TABLE I.—*Solubility of colors, with color of solution—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.                  | Water. | Ethyl alcohol (90.5 per cent by weight). | Methyl alcohol (97 per cent by weight). | Ethyl ether, U.S. P. | Ethyl acetate. | Acetone. | Amyl alcohol. | Glacial acetic acid (99 per cent). | Ammonia water. | Schultz and Julius numbers. |
|-----|---------------------------------|--------|--|---|----------------------|----------------|----------|---------------|------------------------------------|----------------|-----------------------------|
| 92  | Naphthol black BDF (Cassella).  | S      | I  | S                                       | I                    | I              | I        | I             | I                                  | .....          | 188                         |
| 93  | Naphthol blue black (Cassella). | S      | S  | S                                       | I                    | F              | Purple.  | Pale blue.    | S                                  | S              | .....                       |

## NATURAL COLORS.

|    |                    |   |   |   |          |   |          |   |          |             |       |
|----|--------------------|---|---|---|----------|---|----------|---|----------|-------------|-------|
| 94 | Cochineal.         | S | F | I | I        | I | I        | I | S        | Orange.     | 706   |
| 95 | Cubeb (E. & A.).   | F | I | S | Crimson. | S | Crimson. | F | S        | Purple.     | ..... |
| 96 | Archil (E. & A.).  | S | I | S | Crimson. | I | Crimson. | F | Crimson. | .....       | 710   |
| 97 | Litmus eubes.      | S | I | I | I        | I | I        | I | F        | Red.        | ..... |
| 98 | Azo-litmin (Merk). | I | I | I | I        | I | I        | I | F        | Orange red. | ..... |
| 99 | Indigo, Bengal     | I | I | I | I        | I | I        | I | F        | Blue.       | 689   |

TABLE I.—*Solubility of colors, with color of solution—Continued.*

NATURAL COLORS—Continued.

| No. | Name of color.                           | Water.              | Ethyl alcohol (90.5 per cent by weight). | Methyl alcohol (97 per cent by weight). | Ethyl ether, U. S. P. | Ethyl acetate.     | Acetone.           | Amyl alcohol.      | Glycidal acetic acid (99 per cent). | Ammonia water.     | Schultz and Julius numbers. |
|-----|--|---------------------|--|---|-----------------------|--------------------|--------------------|--------------------|-------------------------------------|--------------------|-----------------------------|
| 100 | Alcunlin, oil soluble (German).          | I                   | S<br>Crimson.                            | S                                       | S                     | S                  | S                  | S                  | S<br>Orange red.                    | S<br>Blue.         | .....                       |
| 101 | Coloring matter, log-wood (E. & A.).     | F<br>Brown.         | S  | S                                       | F<br>Orange.          | S                  | S                  | S                  | S                                   | S<br>Red brown.    | 702                         |
| 102 | Coloring matter, Bra-zil wood (E. & A.). | f<br>Orange yellow. | S<br>Orange.                             | S<br>Orange brown.                      | F<br>Yellow.          | S<br>Orange.       | S<br>Orange brown. | S<br>Orange brown. | S<br>Orange brown.                  | S<br>Wine red.     | 701                         |
| 103 | Coloring matter, bar-wood (E. & A.).     | I                   | S<br>Wine red.                           | S<br>Wine red.                          | F<br>Yellow.          | S<br>Orange brown. | S<br>Orange brown. | S<br>Orange brown. | S<br>Orange red.                    | S<br>Maroon.       | 705                         |
| 104 | Catechu (E. & A.).                       | (s, hot water.)     | I  | F<br>Orange yel- low.                   | I                     | I                  | I                  | I                  | I                                   | I                  | 703                         |
| 105 | Yellow color from American safflower.    | S<br>Yellow.        | f<br>Pale yellow.                        | F<br>Yellow.                            | I                     | I                  | I                  | I                  | F                                   | S<br>Yellow brown. | .....                       |
| 106 | Spanish saffron (E. & A.).               | S<br>Orange.        | F<br>Yellow.                             | S<br>Orange.                            | f                     | F                  | F                  | I                  | S                                   | S                  | .....                       |
| 107 | Cape aloes (E. & A.).                    | S<br>Yellow brown.  | S<br>Yellow brown.                       | S                                       | F<br>Yellow.          | F<br>Yellow.       | S                  | F                  | S                                   | S<br>Orange brown. | .....                       |

TABLE I.—*Solubility of colors, with color of solution—Continued.*

NATURAL COLORS—Continued.

| No. | Name of color.                         | Water.             | Ethyl alcohol (90.5 per cent by weight). | Methyl alcohol (97 per cent by weight). | Ethyl ether, U. S. P. | Ethyl acetate. | Acetone. | Amyl alcohol. | Glacial acetic acid (99 per cent). | Ammonia water.     | Schultz and Julius numbers. |
|-----|--|--------------------|--|---|-----------------------|----------------|----------|---------------|------------------------------------|--------------------|-----------------------------|
| 108 | Coloring matter, quereltron (E. & A.). | F<br>Yellow.       | s<br>Yellow brown.                       | f                                       | F                     |                |          | f             | F                                  | s<br>Brown.        | 699                         |
| 109 | Sumac powder (E. & A.).                | S<br>Yellow brown. | I  | F                                       | I                     | I              |          | I             | S                                  | S<br>Yellow brown. | .....                       |
| 110 | Annatto (E. & A.).                     | I                  | F<br>Orange.                             | F                                       | s                     | S              | F        | F             | s                                  | f<br>Orange.       | 709                         |
| 111 | Turnerle.                              | I                  | S<br>Orange.                             |   | F                     | s              | F        | F             | S                                  | F<br>Orange brown. | 707                         |
| 112 | Persian berry extract (Sykes).         | S<br>Yellow.       | F<br>Yellow.                             | F                                       | I                     | I              | I        | f             | F                                  | S<br>Red brown.    | 700                         |
| 113 | Fustic extract, excelsior (Sykes).     | S<br>Yellow brown. | S  | S<br>Yellow.                            |                       | S              | S        | S             | S                                  | S<br>Brown.        | 698                         |
| 114 | Weld extract (Sykes).                  | F<br>Yellow.       | f  | F<br>Yellow.                            | I                     | I              | I        | I             | F<br>Brown yellow.                 | S<br>Yellow brown. | 696                         |
| 115 | Chlorophyl, fat soluble (Germany).     | I                  | S  | S                                       | S                     | S              | S        | S             | S<br>Green.                        | S<br>Green.        | .....                       |
| 116 | Buckthorn berries (Germany, E. & A.).  | S<br>Yellow brown. | F  | S<br>Yellow brown.                      | I                     | I              | I        | I             | S                                  | S<br>Brown.        | 700                         |

TABLE II.—EXTRACTION OF COLORS WITH IMMISCIBLE SOLVENTS FROM AQUEOUS SOLUTIONS.

[Fraction indicates amount of color extracted by one treatment; P = color precipitated from solution by salt.]

## COAL-TAR COLORS.

| No. | Name of color.             | Ethyl acetate. |           |                   | Amyl alcohol. |              |                   | Acetone, from aqueous color solution saturated with salt. |                   |                     |
|-----|----------------------------|----------------|-----------|-------------------|---------------|--------------|-------------------|---|-------------------|---------------------|
|     |                            | Neutral.       | Alkaline. | Acid.             | Neutral.      | Alkaline.    | Acid.             | Neutral.  | Alkaline.         | Acid.               |
| 1   | Ponceau red (Grübler).     | 0              | 0         | 0                 | <½            | Yellow pink. | <½                | P<½   | Orange yellow.    | <½                  |
| 2   | Ponceau 6 R (M. L. B.).    | 0              | 0         | 0                 | 0             | 0            | 0                 | 0   | 0                 | 0                   |
| 3   | Scarlet 6 R (M. L. B.).    | 0              | 0         | 0                 | 0             | 0            | 0                 | 0   | 0                 | 0                   |
| 4   | New coccin (Berlin).       | 0              | 0         | 0                 | 0             | 0            | Nearly 0<br>Pink. | Nearly 0<br>Orange.                                       | Nearly 0<br>Pink. | Nearly 0<br>Orange. |
| 5   | Cochineal red A (Bad.).    | 0              | 0         | 0                 | 0             | 0            | ½                 | 0   | 0                 | ½                   |
| 6   | Ponceau 4 RB (Berlin).     | 0              | 0         | 0                 | <½            | <½           | <½                | ½   | ½                 | ½                   |
| 7   | Crocein scarlet 3 B (By.). | 0              | 0         | 0                 | <½            | Yellow pink. | <½                | ½   | Orange.           | ½                   |
| 8   | Crocein scarlet 7 B (By.). | 0              | 0         | 0                 | 0             | 0            | All extracted.    | ½   | ½                 | >½                  |
| 9   | Fast ponceau B (Bad.).     | 0              | 0         | Nearly 0<br>Pink. | <½            | ½            | ½                 | Orange red.   | ½                 | ½                   |

TABLE II.—*Extraction of colors with immiscible solvents from aqueous solutions—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.                                  | Ethyl acetate. |           |               | Amyl alcohol.                                   |                          |   | Acetone, from aqueous color solution saturated with salt. |   |   |
|-----|---|----------------|-----------|---------------|---|--------------------------|---|---|---|---|
|     |   | Neutral.       | Alkaline. | Acid.         | Neutral.  | Alkaline                 | Acid.   | Neutral.  | Alkaline.   | Acid.   |
| 10  | Bleibrich fast scarlet O (Kalle).               | 0              | 0         | Nearly 0      | Nearly 0<br>Orange pink.                        | Nearly 0<br>Orange pink. | All extracted.<br>Scarlet.                                | <½  | ½   | ½   |
| 11  | Bleibrich crocein scarlet O (Kalle).            | 0              | 0         | 0             | Nearly 0<br>Pink.                               | Nearly 0<br>Pink.        | All extracted.<br>Scarlet.                                | ½   | Red orange.                                       | >½<br>Red orange.                                 |
| 12  | Bleibrich crocein scarlet OO (Kalle).           | 0              | 0         | Nearly 0      | Nearly 0  | Nearly 0                 | All extracted.<br>Scarlet.                                | ½   | ½   | ½<br>Red orange.                                  |
| 13  | Bleibrich brilliant crocein scarlet O (Kalle).  | 0              | 0         | 0             | <½<br>Orange pink.                              | <½<br>Orange pink.       | All extracted.<br>Scarlet.                                | ½   | ½   | >½<br>Red orange.                                 |
| 14  | Bleibrich brilliant crocein scarlet ON (Kalle). | 0              | 0         | <½<br>Orange. | Nearly 0  | Nearly 0                 | Nearly all extracted.<br>Red orange.                      | ½   | <½  | >½<br>Red orange.                                 |
| 15  | Scarlet RD (R, H.).<br>(Mixture.)               | 0              | 0         | <½<br>Orange. | ½   | ½<br>Orange.             | Nearly all extracted.<br>Orange.                          | ½   | ½   | ½<br>Orange.                                      |
| 16  | Ponceau 2 R (Sch.).                             | 0              | 0         | 0             | Nearly 0  | 0                        | Orange red;<br>H <sub>2</sub> O solution,<br>pink.        | >½  | Nearly 0<br>H <sub>2</sub> O solution,<br>orange. | Nearly 0<br>H <sub>2</sub> O solution,<br>orange. |
| 17  | Ponceau 3 R (Sch.).                             | 0              | 0         | 0             | <½<br>H <sub>2</sub> O solution,<br>orange red. | 0<br>Orange.             | Yellow pink;<br>H <sub>2</sub> O solution,<br>orange red. | <½  | Nearly 0<br>Yellow pink.                          | <½<br>Orange.                                     |

TABLE II.—*Extraction of colors with immiscible solvents from aqueous solutions—Continued.*

## COAL-TAR COLORS—Continued.

[Cir. 63]

| No. | Name of color.                      | Ethyl acetate. |                | Amyl alcohol.                      |                                   | Acetone, from aqueous color solution saturated with salt. |                         |               |
|-----|-------------------------------------|----------------|----------------|------------------------------------|-----------------------------------|---|-------------------------|---------------|
|     |                                     | Neutral.       | Alkaline.      | Neutral.                           | Alkaline.                         | Neutral.  | Alkaline.               | Acid.         |
| 18  | Brilliant cochineal 2 R (Cassella). | 0              | 0              | 0                                  | Yellowish.                        | Nearly 0  | Nearly 0                | $\frac{1}{2}$ |
| 19  | Fast red A (Bad.).                  | 0              | Nearly 0       | Nearly all extracted. Yellow pink. | Nearly all extracted. Cherry red. | Nearly all extracted.                                     | Nearly all extracted.   | $\frac{1}{2}$ |
| 20  | Fast red B (Bad.).                  | 0              | 0              | Nearly 0                           | Pink.                             | Nearly 0  | 0                       | $\frac{1}{2}$ |
| 21  | Bordeaux B (Berlin).                | 0              | 0              | 0                                  | Pinkish.                          | Nearly 0  | Orange red.             | $\frac{1}{2}$ |
| 22  | Fast red C (Bad.).                  | 0              | 0              | Nearly 0                           | Pink.                             | $\frac{1}{2}$   | Orange red.             | $\frac{1}{2}$ |
| 23  | Azo rubin (Sch.).                   | 0              | 0              | 0                                  | Pink.                             | $\frac{1}{2}$   | Orange red.             | $\frac{1}{2}$ |
| 24  | Carmosin B (R. H.)                  | 0              | 0              | Nearly 0                           | Pink.                             | Nearly 0  | Orange red.             | $\frac{1}{2}$ |
| 25  | Fast red D (Bad.).                  | $<\frac{1}{2}$ | $<\frac{1}{2}$ | $>\frac{1}{2}$                     | Orange red.                       | $<\frac{1}{2}$  | All extracted. Scarlet. | $\frac{1}{2}$ |
| 26  | Amaranth B (Cassella). (Mixture.)   | 0              | 0              | 0                                  | 0                                 | 0   | 0                       | 0             |

TABLE II.—*Extraction of colors with immiscible solvents from aqueous solutions—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.                         | Ethyl acetate. |                   |  | Amyl alcohol.                                 |                            |  | Acetone, from aqueous color solution saturated with salt. |  |                            |
|-----|--|----------------|-------------------|--|---|----------------------------|--|---|--|----------------------------|
|     |  | Neutral.       | Alkaline.         | Acid.  | Neutral.                                      | Alkaline.                  | Acid.                                  | Neutral.  | Alkaline.                              | Acid.                      |
| 27  | Amaranth (Sch.).                       | 0              | 0                 | 0  | 0   | 0                          | 0                                      | 0   | 0                                      | 0                          |
| 28  | Archil substitute (R. H.).             | 0              | Nearly 0<br>Pink. | Nearly 0<br>Violet ppt. in<br>$H_2O$ solu-<br>tion.          | Nearly all ex-<br>tracted.                    | $>\frac{1}{2}$<br>Scarlet. | All extracted.                         | Nearly all ex-<br>tracted.                                | Nearly all ex-<br>tracted.             | $>\frac{1}{2}$<br>Crimson. |
| 29  | Archil substitute 3 VN<br>(St. Denis). | $<\frac{1}{2}$ | $<\frac{1}{2}$    | $>\frac{1}{2}$<br>Lilac: $H_2O$ so-<br>lution, crim-<br>son. | Red; orange;<br>$H_2O$ solu-<br>tion, purple. | $>\frac{1}{2}$<br>Magenta. | Nearly all ex-<br>tracted.<br>Crimson. | $>\frac{1}{2}$  | Nearly all ex-<br>tracted.<br>Crimson. | $>\frac{1}{2}$<br>Crimson. |
| 30  | Lanafuchsin 6 B (Cassella).            | 0              | 0                 | 0  | Nearly 0                                      | 0                          | $\frac{1}{2}$                          | $\frac{1}{2}$   | Nearly 0                               | $>\frac{1}{2}$             |
| 31  | Magenta.                               | $<\frac{1}{2}$ | $\frac{1}{2}$     | $<\frac{1}{2}$<br>Purple.                                    | $<\frac{1}{2}$<br>Magenta.                    | $\frac{1}{2}$<br>Crimson.  | All extracted.                         | $>\frac{1}{2}$<br>Crimson.                                | $>\frac{1}{2}$                         | $>\frac{1}{2}$             |
| 32  | Acid magenta (Bad.).                   | 0              | 0                 | 0  | 0   | 0                          | 0                                      | 0   | 0                                      | 0                          |
| 33  | Safranin (B. S. S.).                   | 0              | 0                 | $<\frac{1}{2}$<br>Pink.                                      | $>\frac{1}{2}$                                | All extracted.             | $>\frac{1}{2}$<br>Orange red.          | $>\frac{1}{2}$<br>Orange red.                             | $>\frac{1}{2}$<br>Orange red.          | Nearly all ex-<br>tracted. |
| 34  | Benzopurpurin (Grübler).               | 0              | 0                 | $<\frac{1}{2}$<br>Orange red.                                | $<\frac{1}{2}$<br>Orange red.                 | $<\frac{1}{2}$             | Nearly all ex-<br>tracted.             | Nearly all ex-<br>tracted.                                | Nearly all ex-<br>tracted.             | Nearly all ex-<br>tracted. |

TABLE II.—*Extraction of colors with immiscible solvents from aqueous solutions—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.              | Ethyl acetate.                      |                              |                                   | Amyl alcohol.                   |                                 |                                 | Acetone, from aqueous color solution saturated with salt. |                          |   |
|-----|-----------------------------|-------------------------------------|------------------------------|-----------------------------------|---------------------------------|---------------------------------|---------------------------------|---|--------------------------|---|
|     |                             | Neutral.                            | Alkaline.                    | Acid.                             | Neutral.                        | Alkaline.                       | Acid.                           | Neutral.  | Alkaline.                | Acid.   |
| 35  | Congo red (Griibler).       | 0                                   | 0                            | $^0$<br>H <sub>2</sub> O blue.    | Nearly 0                        | < $\frac{1}{2}$                 | $^0$<br>H <sub>2</sub> O blue.  | > $\frac{1}{2}$   | > $\frac{1}{2}$          | < $\frac{1}{2}$<br>Pink; H <sub>2</sub> O blue. |
| 36  | Eosin (Griibler) (mixture). | $>\frac{1}{2}$<br>Yellow.           | $<\frac{1}{2}$<br>Pink.      | $>\frac{1}{2}$<br>Pink.           | $\frac{1}{2}$                   | $>\frac{1}{2}$<br>Yellow.       | $>\frac{1}{2}$<br>Orange pink.  | $\frac{1}{2}$   | $\frac{1}{2}$            | All extracted.<br>Yellow.                       |
| 37  | Eosin A (Bad.).             | $\frac{1}{2}$                       | $\frac{1}{2}$                | > $\frac{1}{2}$                   | > $\frac{1}{2}$                 | $\frac{1}{2}$                   | > $\frac{1}{2}$                 | > $\frac{1}{2}$   | $\frac{1}{2}$            | > $\frac{1}{2}$                                 |
| 38  | Azo-eosin (By.).            | $<\frac{1}{2}$<br>Pink.             | $<\frac{1}{2}$<br>Pink.      | $\frac{1}{2}$<br>Orange.          | $\frac{1}{2}$                   | $>\frac{1}{2}$<br>Orange.       | $>\frac{1}{2}$<br>Yellow pink.  | $\frac{1}{2}$   | $\frac{1}{2}$            | $>\frac{1}{2}$<br>Red orange.                   |
| 39  | Phloxin (Bad.).             | $\frac{1}{2}$<br>Yellow fluor.      | $\frac{1}{2}$<br>Yellow.     | $>\frac{1}{2}$<br>Pink, no fluor. | $\frac{1}{2}$                   | $>\frac{1}{2}$<br>Yellow.       | $>\frac{1}{2}$<br>Orange fluor. | $\frac{1}{2}$   | $\frac{1}{2}$            | Nearly all ex-<br>tracted.<br>Yellow.           |
| 40  | Rose bengal (Bad.).         | 0                                   | $\frac{1}{2}$                | $\frac{1}{2}$                     | $\frac{1}{2}$                   | $\frac{1}{2}$                   | > $\frac{1}{2}$                 | $>\frac{1}{2}$<br>Orange red.                             | > $\frac{1}{2}$          | Orange yellow.                                  |
| 41  | Rhodamin (Bad.).            | $<\frac{1}{2}$<br>Yellow fluor.     | < $\frac{1}{2}$              | $\frac{1}{2}$<br>Fluor.           | All extracted.<br>Orange fluor. | All extracted.<br>Fluor.        | All extracted.<br>Fluor.        | $>\frac{1}{2}$<br>Fluor.                                  | $>\frac{1}{2}$<br>Fluor. | Fluor.  |
| 42  | Pink M (R. H.).             | $>\frac{1}{2}$<br>Nearly colorless. | $>\frac{1}{2}$<br>Colorless. | $\frac{1}{2}$                     | All extracted.<br>Yellow fluor. | All extracted.<br>Yellow fluor. | $>\frac{1}{2}$<br>Fluor.        | $\frac{1}{2}$<br>Fluor.                                   | $>\frac{1}{2}$<br>Fluor. | Fluor.  |

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TABLE II.—*Extraction of colors with immiscible solvents from aqueous solutions—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.            | Ethyl acetate.                                   |                                  |                                  | Amyl alcohol.                                   |   |  | Acetone, from aqueous color solution saturated with salt. |                               |                                   |
|-----|---------------------------|--|----------------------------------|----------------------------------|---|---|--|---|-------------------------------|-----------------------------------|
|     |                           | Neutral.   | Alkaline.                        | Acid.                            | Neutral.  | Alkaline.                               | Acid.  | Neutral.  | Alkaline.                     | Acid.                             |
| 43  | Fast pink B (Seh.).       | Nearly all extracted. Colorless.                 | Nearly all extracted. Colorless. | $\frac{1}{2}$ Pink.              | All extracted. Yellow fluor.                    | All extracted. Yellow fluor.            | $\frac{1}{2}$ Yellow fluor.                              | Yellow fluor.   | $\frac{1}{2}$ Phlor.          | $\frac{1}{2}$ Phlor.              |
| 44  | Erythrosin.               | Nearly all extracted. Orange fluor; $H_2O$ pink. | Nearly 0                         | All extracted. Orange.           | $\frac{1}{2}$ Deep pink; $H_2O$ red orange.     | $<\frac{1}{2}$ Pink; $H_2O$ red orange. | All extracted. Red orange.                               | $>\frac{1}{2}$ Fluor.                                     | All extracted. Red orange.    | All extracted. Orange.            |
| 45  | Tropacolin O (Cassella).  | 0  | 0                                | $<\frac{1}{2}$                   | $<\frac{1}{2}$ Yellow; $H_2O$ solution, orange. | 0                                       | Nearly all extracted. Orange.                            | $\frac{1}{2}$   | $<\frac{1}{2}$                | $>\frac{1}{2}$                    |
| 46  | Tropacolin OO (Cassella). | $<\frac{1}{2}$                                   | $<\frac{1}{2}$                   | Yellow.                          | $>\frac{1}{2}$                                  | $>\frac{1}{2}$                          | All extracted.   | $>\frac{1}{2}$  | Nearly all extracted.         | $>\frac{1}{2}$                    |
| 47  | Orange IV (R. H.).        | $<\frac{1}{2}$                                   | $\frac{1}{2}$                    | Yellow; $H_2O$ solution, orange. | $\frac{1}{2}$                                   | $\frac{1}{2}$                           | Nearly all extracted. Orange red; $H_2O$ solution, pink. | Nearly all extracted. Orange.                             | Nearly all extracted. Orange. | Nearly all extracted. Red orange. |
| 48  | Methyl orange.            | 0  | Nearly 0                         | 0                                | $<\frac{1}{2}$                                  | $<\frac{1}{2}$                          | $\frac{1}{2}$  | $\frac{1}{2}$   | $\frac{1}{2}$                 | $\frac{1}{2}$                     |
| 49  | Orange extra (Cassella).  | 0  | 0                                | $\frac{1}{2}$                    | All extracted.                                  | $\frac{1}{2}$                           | All extracted.   | $\frac{1}{2}$   | $\frac{1}{2}$                 | $>\frac{1}{2}$                    |

TABLE II.—*Extraction of colors with immiscible solvents from aqueous solutions—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.                          | Ethyl acetate. |                                    |                | Amyl alcohol.  |   |   | Acetone, from aqueous color solution saturated with salt. |                            |                                       |
|-----|---|----------------|------------------------------------|----------------|----------------|---|---|---|----------------------------|---------------------------------------|
|     |   | Neutral.       | Alkaline.                          | Acid.          | Neutral.       | Alkaline.                                 | Acid.   | Neutral.  | Alkaline.                  | Acid.                                 |
| 50  | Orange II (St. Denis).                  | Nearly 0       | 0                                  | $\frac{1}{2}$  | $\frac{1}{2}$  | $<\frac{1}{2}$                            | All extracted.<br>Orange.                                       | $>\frac{1}{2}$  | $\frac{1}{2}$              | $>\frac{1}{2}$                        |
| 51  | Orange II (By.).                        | 0              | 0                                  | $\frac{1}{2}$  | $\frac{1}{2}$  | $\frac{1}{2}$                             | All extracted.<br>Nearly all ex-<br>tracted.                    | $>\frac{1}{2}$  | $>\frac{1}{2}$             | $>\frac{1}{2}$                        |
| 52  | Tylenond orange (R. II.).<br>(Mixture.) | 0              | Nearly 0                           | $<\frac{1}{2}$ | $<\frac{1}{2}$ | $<\frac{1}{2}$                            | Nearly all ex-<br>tracted.<br>Orange; $H_2O$<br>solution, pink. | $>\frac{1}{2}$  | $>\frac{1}{2}$             | Nearly all ex-<br>tracted.<br>Orange. |
| 53  | Crocein orange Y (Sch.).                | 0              | 0                                  | $\frac{1}{2}$  | All extracted. | $>\frac{1}{2}$                            | All extracted.  | $>\frac{1}{2}$  | $\frac{1}{2}$              | $>\frac{1}{2}$                        |
| 54  | Orange I.                               | Nearly 0       | $H_2O$<br>Scarlet.<br>Pale yellow. | $\frac{1}{2}$  | $\frac{1}{2}$  | $<\frac{1}{2}$ orange;<br>$H_2O$ scarlet. | All extracted.<br>Orange.                                       | $>\frac{1}{2}$  | $\frac{1}{2}$              | $>\frac{1}{2}$<br>Orange.             |
| 55  | Crocein orange G (By.).                 | 0              | 0                                  | $\frac{1}{2}$  | $>\frac{1}{2}$ | $\frac{1}{2}$                             | All extracted.  | Nearly all ex-<br>tracted.                                | $\frac{1}{2}$              | Nearly all ex-<br>tracted.            |
| 56  | Ponceau 4 G B (Berlin).                 | 0              | 0                                  | $\frac{1}{2}$  | All extracted. | Nearly all ex-<br>tracted.                | All extracted.  | Nearly all ex-<br>tracted.                                | Nearly all ex-<br>tracted. | All extracted.                        |
| 57  | Orange G (Berlin).                      | 0              | 0                                  | 0              | 0              | 0   | $\frac{1}{2}$   | $\frac{1}{2}$   | $<\frac{1}{2}$             | $\frac{1}{2}$                         |
| 58  | Orange G (R. II.).                      | 0              | 0                                  | $\frac{1}{2}$  | $>\frac{1}{2}$ | $\frac{1}{2}$                             | All extracted.  | $>\frac{1}{2}$  | $>\frac{1}{2}$             | $>\frac{1}{2}$                        |

TABLE II.—*Extraction of colors with immiscible solvents from aqueous solutions—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.                                    | Ethyl acetate. |                                    |                                    | Amyl alcohol.  |                                  |                       | Acetone, from aqueous color solution saturated with salt. |                       |                       |
|-----|---|----------------|------------------------------------|------------------------------------|----------------|----------------------------------|-----------------------|---|-----------------------|-----------------------|
|     |   | Neutral.       | Alkaline.                          | Acid.                              | Neutral.       | Alkaline.                        | Acid.                 | Neutral.  | Alkaline.             | Acid.                 |
| 59  | Orange G crystals (Castella).                     | 0              | 0                                  | 0                                  | 0              | 0                                | >½                    | <½<br>Yellow.   | <½<br>Yellow.         | ½                     |
| 60  | Auramine.   | Nearly 0       | All extracted.                     | 0                                  | All extracted. | All extracted.                   | Nearly all extracted. | >½  | Nearly all extracted. | ½                     |
| 61  | Naphthol yellow (Bad.).                           | 0              | H <sub>2</sub> O solution, yellow. | H <sub>2</sub> O solution, yellow. | Nearly 0       | Nearly 0                         | <½                    | ½   | ½                     | >½                    |
| 62  | Yellow YM (R. H.).                                | 0              | 0                                  | ½                                  | <½             | Nearly 0                         | ½                     | ½   | ½                     | >½                    |
| 63  | Naphthol yellow or naphthylamin yellow (Grübler). | ½              | All extracted.                     | ½                                  | ½              | ½                                | All extracted.        | All extracted.  | All extracted.        | All extracted.        |
| 64  | Martius yellow.                                   | >½             | ½                                  | ½                                  | ½              | ½                                | All extracted.        | Pale yellow.  | Nearly all extracted. | Nearly all extracted. |
| 65  | Phloro acid.                                      | ½              | <½                                 | All extracted.                     | ½              | <½                               | All extracted.        | >½  | >½                    | >½                    |
| 66  | Chrysamin.  | All extracted. | <½                                 | All extracted.                     | >½             | Yellow; H <sub>2</sub> O orange. | All extracted.        | Nearly all extracted.                                     | P < ½                 | All extracted.        |
| 67  | Fast yellow (Bad.).                               | 0              | 0                                  | 0                                  | Nearly 0       | Nearly 0                         | ½                     | ½   | ½                     | <½                    |

TABLE II.—*Extraction of colors with immiscible solvents from aqueous solutions*—Continued.

## COAL-TAR COLORS—Continued.

| No. | Name of color.              | Ethyl acetate. |   |  | Amyl alcohol.                |                              |  | Acetone, from aqueous color solution saturated with salt. |
|-----|-----------------------------|----------------|---|--|------------------------------|------------------------------|--|---|
|     |                             | Neutral.       | Alkaline.                               | Acid.  | Neutral.                     | Alkaline.                    | Acid.  |   |
| 68  | Wool yellow T extra (Sch.). | 0              | 0                                       | 0  | 0                            | Yellow.                      | Nearly 0<br>Pale yellow.                               | $\frac{1}{2}$<br>Yellow.                                  |
| 69  | Tartrazin (Bad.).           | 0              | 0                                       | 0  | 0                            | $\frac{1}{2}$                | 0  | 0   |
| 70  | Metanil yellow (Oehler).    | $<\frac{1}{2}$ | $<\frac{1}{2}$                          | $\frac{1}{2}$  | $>\frac{1}{2}$               | $\frac{1}{2}$                | Nearly all ex-<br>tracted.<br>Brown red.               | $>\frac{1}{2}$  |
| 71  | Brilliant yellow S (Sch.).  | 0              | 0                                       | $\frac{1}{2}$<br>H <sub>2</sub> O solution,<br>orange. | 0                            | 0                            | $\frac{1}{2}$<br>H <sub>2</sub> O solution,<br>orange. | 0   |
| 72  | "Chinolin yellow" (R. H.).  | Nearly 0       | Nearly 0                                | $\frac{1}{2}$  | $\frac{1}{2}$                | $>\frac{1}{2}$               | Nearly all ex-<br>tracted.<br>Orange.                  | $\frac{1}{2}$   |
| 73  | Chrysoidin (Gribler).       | $\frac{1}{2}$  | All extracted.                          | $<\frac{1}{2}$   | $\frac{1}{2}$                | Nearly all ex-<br>tracted.   | Nearly all ex-<br>tracted.<br>Orange.                  | $>\frac{1}{2}$  |
| 77  | Malachite green (Berlin).   | Nearly 0       | All color ex-<br>tracted.<br>Colorless. | $\frac{1}{2}$<br>Greenish blue.                        | All extracted.<br>Deep blue. | All extracted.<br>Colorless. | All extracted.<br>Colorless.                           | Nearly all ex-<br>tracted.<br>Greenish blue.              |

TABLE II.—*Extraction of colors with immiscible solvents from aqueous solutions—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.                | Ethyl acetate. |                                 |   | Amyl alcohol.                                     |                                       |   | Acetone, from aqueous color solution saturated with salt. |   |  |
|-----|-------------------------------|----------------|---------------------------------|---|---|---------------------------------------|---|---|---|--|
|     |                               | Neutral.       | Alkaline.                       | Acid.   | Neutral.  | Alkaline.                             | Acid.   | Neutral.  | Alkaline.                                   | Acid.  |
| 78  | Ethyl green (Berlin).         | Nearly 0       | All color extracted. Colorless. | All color extracted. Greenish blue.                     | All extracted. Deep blue.                         | All extracted. Colorless.             | All extracted. Pale green blue.                     | All extracted. Deep blue.                                 | All extracted. Colorless.                   | All extracted. Pale green blue.                |
| 79  | Acid green 780 (Cassella).    | 0              | 0                               | $\frac{0}{H_2O}$ solution, nearly colorless.            | $\frac{<\frac{1}{2}}{H_2O}$ solution, pale green. | 0                                     | $\frac{1}{2}$ Greenish blue.                        | 0   | $\frac{0}{H_2O}$ solution, colorless.       | 0  |
| 80  | Acid green OO (Sch.).         | 0              | 0                               | 0   | 0   | 0                                     | $\frac{>\frac{1}{2}}{Blue}$ green.                  | 0   | 0   | Nearly 0                                       |
| 81  | Cyanole green 6 G (Cassella). | 0              | 0                               | $\frac{0}{H_2O}$ solution, yellow green.                | $\frac{>\frac{1}{2}}{H_2O}$ solution, pale green. | $\frac{0}{H_2O}$ solution, deep blue. | $\frac{\frac{1}{2}}{Same as acetone.}$              | $\frac{0}{Blue}$ .  | $\frac{0}{Colorless; H_2O solution, blue.}$ | $\frac{0}{Blue; H_2O solution, yellow green.}$ |
| 82  | Naphthol green B (Cassella).  | 0              | 0                               | $\frac{0}{H_2O}$ solution, yellow green.                | $\frac{0}{H_2O}$ solution, green.                 | 0                                     | $\frac{0}{Brownish yellow; H_2O solution, yellow.}$ | 0   | 0   | 0  |
| 83  | Azo blue (By.).               | 0              | 0                               | Dark blue precipitate; $\frac{1}{H_2O}$ solution, pink. | $\frac{1}{Crimson.}$                              | $\frac{<\frac{1}{2}}{Crimson.}$       | Nearly all extracted. Magenta.                      | $\frac{1}{2}$   | $\frac{<\frac{1}{2}}{Crimson.}$             | Nearly all extracted. Crimson.                 |
| 84  | Cyanole FF (Cassella).        | 0              | 0                               | $\frac{0}{H_2O}$ solution, blue.                        | $\frac{0}{H_2O}$ solution, green.                 | $\frac{<\frac{1}{2}}{Blue.}$          | $\frac{0}{Blue; H_2O solution, green.}$             | $\frac{\frac{1}{2}}{Blue.}$                               | 0   | $\frac{0}{Blue; H_2O solution, green.}$        |

TABLE II.—*Extraction of colors with immiscible solvents from aqueous solutions—Continued.*  
COAL-TAR COLORS—Continued.

| Cir. 63] | No.                             | Name of color. | Ethyl acetate.  |  |   | Amyl alcohol.         |  |                                 | Acetone, from aqueous color solution saturated with salt.         |   |  |
|----------|---------------------------------|----------------|-----------------|--|---|-----------------------|--|---------------------------------|---|---|--|
|          |                                 |                | Neutral.        | Alkaline.                              | Acid.                                     | Neutral.              | Alkaline.                                    | Acid.                           | Neutral.  | Alkaline.                                 | Acid.  |
| 85       | Methylene blue (Bad.).          | 0              | 0               | 0                                      | 0   | 0                     | 0  | 0                               | Very little extracted.<br>Blue; H <sub>2</sub> O solution, green. | > $\frac{1}{2}$<br>Blue.                  | > $\frac{1}{2}$  |
| 86       | Tetracyanole SF (Cassella).     | 0              | 0               | 0                                      | 0   | 0                     | 0  | 0                               | Nearly 0  | Nearly 0                                  | < $\frac{1}{2}$<br>Blue; H <sub>2</sub> O solution, green; yellow. |
| 87       | Methyl violet DB (Sch.).        | Nearly 0       | $\frac{1}{2}$   | < $\frac{1}{2}$                        | Violet; H <sub>2</sub> O solution, green. | Nearly all extracted. | All extracted.                               | $\frac{1}{2}$                   | Nearly all extracted.   | > $\frac{1}{2}$                           | $\frac{1}{2}$<br>H <sub>2</sub> O solution, blue.                  |
| 88       | Methylene violet 2 BX (Berlin). | Nearly 0       | $\frac{1}{2}$   | < $\frac{1}{2}$                        | Violet; H <sub>2</sub> O solution, blue.  | $\frac{1}{2}$         | All extracted.                               | All extracted.                  | Nearly all extracted.   | All extracted.                            | > $\frac{1}{2}$<br>H <sub>2</sub> O solution, blue.                |
| 89       | Indigo disulpho-acid.           | 0              | 0               | 0                                      | 0   | 0                     | 0  | 0                               | Nearly 0  | Violet.                                   | < $\frac{1}{2}$  |
| 90       | Bismarck brown extra (Berlin).  |                | < $\frac{1}{2}$ | Nearly all extracted.<br>Brown orange. | 0   | $\frac{1}{2}$         | Nearly all extracted.<br>Brown orange.       | $\frac{1}{2}$                   | Nearly all extracted.   | > $\frac{1}{2}$                           | $\frac{1}{2}$<br>Brown orange.                                     |
| 91       | Fast brown G (Berlin).          | 0              | 0               | H <sub>2</sub> O solution, crimson.    | $\frac{1}{2}$                             | All extracted.        | Crimson; H <sub>2</sub> O solution, magenta. | < $\frac{1}{2}$                 | All extracted.  | Brown; H <sub>2</sub> O solution, purple. | > $\frac{1}{2}$  |
| 92       | Naphthol black BDF (Cassella).  | 0              | 0               | H <sub>2</sub> O purple.               | 0   | 0                     | H <sub>2</sub> O violet.                     | 0                               | 0   | H <sub>2</sub> O blue.                    | 0  |
| 93       | Naphthol blue black.            | 0              | 0               | Purple.                                | $\frac{1}{2}$                             | 0                     | 0  | All extracted.<br>Deep crimson. | Deep crimson.<br>H <sub>2</sub> O blue.                           | $\frac{1}{2}$<br>Blue.                    | Deep crimson.<br>H <sub>2</sub> O blue.                            |

TABLE II.—*Extraction of colors with immiscible solvents from aqueous solutions*—Continued.

## NATURAL COLORS.

[Cir. 63]

| No. | Name of color.       | Ethyl acetate.                                    |  |   | Amyl alcohol.                                     |   |                                    | Acetone, from aqueous color solution saturated with salt. |               |  |
|-----|----------------------|---|--|---|---|---|------------------------------------|---|---------------|--|
|     |                      | Neutral.  | Alkaline.  | Acid.   | Neutral.  | Alkaline.   | Acid.                              | Neutral.  | Alkaline.     | Acid.                                      |
| 94  | Cochineal.           | 0   | 0  | ½<br>Orange.  | Nearly 0  | 0   | Nearly all extracted.<br>Orange.   | 0   | 0             | >½<br>Orange.                              |
| 95  | Cudbear.             | ½<br>Wine red; H <sub>2</sub> O solution, purple. | <½<br>Wine red; H <sub>2</sub> O solution, purple. | ½<br>Scarlet; H <sub>2</sub> O solution, deep pink. | Nearly all extracted.<br>Wine red.                | <½<br>Purple.                                     | Nearly all extracted.<br>Wine red. | >½<br>Crimson.  | ½<br>Crimson. | >½<br>Crimson.                             |
| 96  | Archil.              | <½<br>Red orange.                                 | <½<br>Deep pink.                                   | ½<br>Orange red.                                    | ½<br>Scarlet; H <sub>2</sub> O solution, magenta. | <½<br>Magenta; H <sub>2</sub> O solution, purple. | >½<br>Wine red.                    | ½<br>Scarlet.   | ½<br>Crimson. | Nearly all extracted.<br>Wine red.         |
| 97  | Litmus.              | 0   | 0  | 0   | 0   | 0   | ½<br>Pink.                         | 0   | 0             | Nearly all extracted.<br>Deep yellow pink. |
| 98  | Azo litmin.          | 0   | 0  | 0   | 0   | 0   | <½<br>Pink.                        | 0   | 0             | >½<br>Deep pink.                           |
| 101 | Logwood extract.     | Nearly all extracted.<br>Brown.                   | 0  | <½<br>Brown yellow.                                 | All extracted.<br>Brown.                          | Nearly 0  | ½<br>Brown.                        | >½<br>Red orange; H <sub>2</sub> O solution, magenta.     | 0             | ½<br>Red brown.                            |
| 102 | Brazil-wood extract. | Nearly all extracted.<br>Yellow.                  | Nearly 0   | >½<br>Orange yellow.                                | All extracted.<br>Yellow.                         | Nearly 0  | >½<br>Orange.                      | ½<br>Orange; H <sub>2</sub> O solution, wine red.         | 0             | Nearly all extracted.<br>Orange.           |

TABLE II.—*Extraction of colors with immiscible solvents from aqueous solutions—Continued.*

## NATURAL COLORS—Continued.

| No. | Name of color.        | Ethyl acetate.               |   |  | Amyl alcohol.                 |   |   | Acetone, from aqueous color solution saturated with salt.                 |
|-----|-----------------------|------------------------------|---|--|-------------------------------|---|---|---|
|     |                       | Neutral.                     | Alkaline.   | Acid.  | Neutral.                      | Alkaline.                               | Acid.   |   |
| 104 | Catechu.              | 0                            | 0   | Nearly 0   | 0                             | Nearly 0                                | 0   | < $\frac{1}{2}$ Brown.  |
| 105 | Saffron.              | < $\frac{1}{2}$              | < $\frac{1}{2}$   | 0  | < $\frac{1}{2}$ Orange.       | $\frac{1}{2}$ Orange yellow.            | $\frac{1}{2}$ Yellow.   | $\frac{1}{2}$   |
| 106 | Aloes.                | $\frac{1}{2}$ Yellow.        | Orange; $\frac{1}{2}$ $\text{H}_2\text{O}$ solution, red brown. | Red; orange; $\frac{1}{2}$ $\text{H}_2\text{O}$ solution, brown.     | > $\frac{1}{2}$               | Red brown.                              | < $\frac{1}{2}$ Scarlet.  | > $\frac{1}{2}$ Brown yellow; $\text{H}_2\text{O}$ solution, pale yellow. |
| 107 | Quercitron extract.   | > $\frac{1}{2}$ Yellow.      | Nearly 0 $\text{H}_2\text{O}$ solution, brown.                  | Nearly all extracted, Yellow.  | > $\frac{1}{2}$               | 0 $\text{H}_2\text{O}$ solution, brown. | > $\frac{1}{2}$ Brown yellow; $\text{H}_2\text{O}$ solution, brown. | Nearly 0 $\text{H}_2\text{O}$ solution, brown.                            |
| 108 | Sumac extract.        | > $\frac{1}{2}$ Pale yellow. | 0   | $\frac{1}{2}$  | Nearly all extracted, Yellow. | 0                                       | Nearly all extracted, Yellow.                                       | > $\frac{1}{2}$ Yellow brown.   |
| 109 | Anatto.               | .....                        | > $\frac{1}{2}$ Orange.   | .....  | Nearly all extracted, Orange. | > $\frac{1}{2}$ Orange.                 | .....   | > $\frac{1}{2}$ Yellow.   |
| 110 | Turneric.             | > $\frac{1}{2}$ Yellow.      | All extracted. Yellow.  | > $\frac{1}{2}$ Yellow.  | 0                             | Nearly all extracted, Yellow.           | All extracted. Yellow.  | Nearly 0 Yellow.  |
| 111 | Yerian berry extract. | < $\frac{1}{2}$ Yellow.      | Nearly 0  | < $\frac{1}{2}$ Yellow; $\text{H}_2\text{O}$ solution, yellow brown. | < $\frac{1}{2}$ Yellow.       | < $\frac{1}{2}$ Yellowish.              | < $\frac{1}{2}$ Yellow; $\text{H}_2\text{O}$ solution, yellow.      | > $\frac{1}{2}$ Yellow; $\text{H}_2\text{O}$ solution, brownish.          |

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TABLE II.—*Extraction of colors with immiscible solvents from aqueous solutions—Continued.*

## NATURAL COLORS—Continued.

| No. | Name of color.                   | Ethy acetate. |           |  | Amyl alcohol.     |   |   | Acetone, from aqueous color solution saturated with salt.            |  |  |
|-----|----------------------------------|---------------|-----------|--|-------------------|---|---|--|--|--|
|     |                                  | Neutral.      | Alkaline. | Acid.                                      | Neutral.          | Alkaline.   | Acid.                                       | Neutral.   | Alkaline.  | Acid.                                  |
| 113 | Fustic extract.                  | ½             | Nearly 0  | <½<br>Yellow.                              | Nearly 0          | Nearly 0  | Nearly all extracted.<br>Yellow brown.      | >½<br>Yellow brown.  | <½<br>Yellow.  | Nearly all extracted.<br>Yellow brown. |
| 114 | Weld extract.                    | 0             | 0         | <½<br>Yellow.                              | <½<br>Yellow.     | <½<br>Yellow.   | Nearly colorless.                           | <½<br>Yellow.  | <½<br>Yellow.  | >½<br>Brown yellow.                    |
| 115 | Buckthorn berries.               | ½             | <½        | >½<br>Yellow.                              | >½<br>Yellow.     | <½<br>Bright orange.                                    | Nearly all extracted.<br>Yellow.            | All extracted.<br>Yellow, H <sub>2</sub> O solution,<br>light brown. | 0<br>H <sub>2</sub> O solution,<br>brown.              | >½<br>Yellow.                          |
| 116 | Strawberry juice, fresh.         | 0             | 0         | H <sub>2</sub> O solution,<br>magenta.     | Nearly 0          | <½<br>Colorless; H <sub>2</sub> O solution,<br>magenta. | ½<br>Scarlet.                               | Light brown;<br>H <sub>2</sub> O solution,<br>dark-gray brown.       | 0<br>H <sub>2</sub> O solution,<br>gray blue.          | Scarlet.                               |
| 117 | Blackberry juice, old.           | 0             | 0         | H <sub>2</sub> O solution,<br>blue.        | 0                 | 0<br>H <sub>2</sub> O solution,<br>blue gray.           | 0<br>,                                      | 0<br>H <sub>2</sub> O solution,<br>magenta.                          | 0<br>H <sub>2</sub> O solution,<br>gray blue.          | Nearly 0<br>Pale pink.                 |
| 118 | Red raspberry juice, oil.        | 0             | 0         | H <sub>2</sub> O solution,<br>deep blue.   | 0                 | 0<br>H <sub>2</sub> O solution,<br>deep blue.           | 0<br>H <sub>2</sub> O solution,<br>magenta. | 0<br>H <sub>2</sub> O solution,<br>magenta.                          | 0<br>Yellow.   | 0<br>Orange.                           |
| 119 | Dark, sweet cherry juice, fresh. | 0             | 0         | H <sub>2</sub> O solution,<br>dark purple. | Nearly 0<br>Pink. | 0<br>H <sub>2</sub> O solution,<br>green brown.         | Nearly 0<br>Pink.                           | 0<br>H <sub>2</sub> O solution,<br>brown green.                      | <½<br>Orange; red;<br>H <sub>2</sub> O solution, same. |  |

TABLE II.—*Extraction of colors with immiscible solvents from aqueous solutions—Continued.*

## NATURAL COLORS—Continued.

[Cir. 63]

| No. | Name of color.        | Ethyl acetate. |  |                          | Amyl alcohol.                       |  |   | Acetone, from aqueous color solution saturated with salt. |
|-----|-----------------------|----------------|--|--------------------------|-------------------------------------|--|---|---|
|     |                       | Neutral.       | Alkaline.                                      | Acid.                    | Neutral.                            | Alkaline.                                    | Acid.   |   |
| 121 | Grape juice, Concord. | 0              | 0  | 0                        | $\frac{1}{2}$                       | Deep pink.                                   | 0   | 0<br>H <sub>2</sub> O solution, brown green.              |
| 122 | Poke-berry extract.   | 0              | Yellowish; H <sub>2</sub> O solution, crimson. | 0                        | 0                                   | Yellowish; H <sub>2</sub> O solution, brown. | $\frac{1}{2}$   | Yellowish; H <sub>2</sub> O solution, brown green.        |
| 123 | Spinach green.        | $\frac{1}{2}$  | Nearly all extracted. Yellow green.            | $\frac{1}{2}$            | Nearly all extracted. Yellow green. | Nearly all extracted. Greenish yellow.       | 0   | Nearly all extracted. Brown.                              |
| 124 | Curcumin (Grübler).   | 0              | 0  | $\frac{1}{2}$<br>Orange. | 0                                   | 0  | $\frac{1}{2}$<br>Red orange; H <sub>2</sub> O solution, pink. | 0<br>Orange red.  |
| 125 | Tomato color.         | $\frac{1}{2}$  | Orange.  | $\frac{1}{2}$            | All extracted. Orange yellow.       | All extracted. Orange.                       | 0   | All extracted. Orange.                                    |

TABLE III.—COLOR REACTIONS OF DYED FIBER (WOOL).  
COAL-TAR COLORS.

| No. | Name of color.                   | Concentrated hydrochloric acid. |           | Concentrated sulphuric acid. |           | 10 per cent caustic soda solution. |               | Ammonia 0.95. |           |
|-----|----------------------------------|---------------------------------|-----------|------------------------------|-----------|------------------------------------|---------------|---------------|-----------|
|     |                                  | Fiber.                          | Solution. | Fiber.                       | Solution. | Fiber.                             | Solution.     | Fiber.        | Solution. |
| 1   | Ponceau red (Tribbler).          | Crimson.                        | Pink.     | Scarlet.                     | Scarlet.  | Orange red.                        | .....         | No change.    | Red.      |
| 2   | Ponceau 6 R (M. I., B.).         | Crimson.                        | Red.      | Violet.                      | Violet.   | Brown.                             | Brown.        | No change.    | Red.      |
| 3   | Scarlet 6 R (M. I., B.).         | Scarlet.                        | .....     | Lilac.                       | .....     | Orange brown.                      | .....         | Darker.       | Red.      |
| 4   | New cochineal (Berlin).          | Orange red.                     | Red.      | Purple.                      | Purple.   | Light brown.                       | Light brown.  | No change.    | Reddish.  |
| 5   | Cochineal red A (Bad.).          | Crimson.                        | Red.      | Deep crimson.                | Pink.     | Yellow brown.                      | Yellow brown. | No change.    | Red.      |
| 6   | Ponceau 4 R B (Berlin).          | Dark blue.                      | Blue.     | Dark blue.                   | Blue.     | Dark crimson.                      | .....         | No change.    | Red.      |
| 7   | Crocein scarlet 3 B (By.).       | Dark blue.                      | Blue.     | Dark blue.                   | Blue.     | Violet brown.                      | .....         | No change.    | Red.      |
| 8   | Crocein scarlet 7 B (By.).       | Blue.                           | Blue.     | Blue.                        | Blue.     | Maroon.                            | .....         | No change.    | Red.      |
| 9   | Fast ponceau B (Bad.).           | Dark blue.                      | Blue.     | Deep green.                  | Green.    | Brown violet.                      | .....         | No change.    | .....     |
| 10  | Biebrich fast scarlet O (Kalle). | Dark blue.                      | Blue.     | Dark blue.                   | Blue.     | Purple.                            | .....         | No change.    | .....     |

TABLE III.—*Color reactions of dyed fiber (wool)—Continued.*

| COAL-TAR COLORS—Continued. |   |                                 |           |                              |           |                                    |                  |                            |
|----------------------------|---|---------------------------------|-----------|------------------------------|-----------|------------------------------------|------------------|----------------------------|
| No.                        | Name of color.                                  | Concentrated hydrochloric acid. |           | Concentrated sulphuric acid. |           | 10 per cent caustic soda solution. |                  | Ammonia 0.95.<br>Solution. |
|                            |   | Fiber.                          | Solution. | Fiber.                       | Solution. | Fiber.                             | Solution.        |                            |
| 11                         | Biebrich crocein scarlet O (Kalle).             | Dark blue.                      | Blue.     | Dark blue.                   | Blue.     | Dark brown.                        | .....            | No change.<br>Red.         |
| 12                         | Biebrich crocein scarlet O O (Kalle).           | Dark blue.                      | Blue.     | Dark blue.                   | Blue.     | Brown.                             | .....            | No change.<br>Red.         |
| 13                         | Biebrich brilliant crocein scarlet O (Kalle).   | Dark blue.                      | Blue.     | Purple.                      | Purple.   | Dark brown.                        | .....            | No change.<br>Red.         |
| 14                         | Biebrich brilliant crocein scarlet O N (Kalle). | Dark blue.                      | Blue.     | Purple.                      | Purple.   | Dark brown.                        | .....            | No change.<br>Pink.        |
| 15                         | Scarlet RD (R. II.) (mixture).                  | .....                           | Crimson.  | .....                        | Red.      | Yellower.                          | .....            | No change.                 |
| 16                         | Ponceau 2 R (Sch.).                             | .....                           | Rose red. | .....                        | Darker.   | Red.                               | Orange.          | .....                      |
| 17                         | Ponceau 3 R (Sch.).                             | .....                           | Rose red. | .....                        | Scarlet.  | Red.                               | Orange.          | .....                      |
| 18                         | Brilliant cochineal 2 R (Cassella).             | .....                           | Darker.   | .....                        | Crimson.  | .....                              | Brownish yellow. | No change.<br>Red.         |
| 19                         | Fast red A (Batl.).                             | .....                           | Purple.   | Violet.                      | Violet.   | Deep orange brown.                 | Red.             | No change.                 |

TABLE III.—*Color reactions of dyed fiber (wool)—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.                   | Concentrated hydrochloric acid. |            | Concentrated sulphuric acid. |           | 10 per cent caustic soda solution. |           | Ammonia 0.95. |            |
|-----|----------------------------------|---------------------------------|------------|------------------------------|-----------|------------------------------------|-----------|---------------|------------|
|     |                                  | Fiber.                          | Solution.  | Fiber.                       | Solution. | Fiber.                             | Solution. | Fiber.        | Solution.  |
| 20  | Fast red B (Bad.)                | Purple.                         | .....      | Dark blue.                   | Blue.     | Light orange brown.                | .....     | No change.    | .....      |
| 21  | Bordeaux B (Berlin).             | Bluer.                          | Colorless. | Blue.                        | Blue.     | Orange red.                        | Red.      | No change.    | Colorless. |
| 22  | Fast red C (Bad.)                | Crimson.                        | .....      | Purple violet.               | Violet.   | Scarlet.                           | Red.      | Redder.       | Red.       |
| 23  | Azorubin (Sch.).                 | Crimson.                        | .....      | Violet.                      | Violet.   | Red.                               | Red.      | No change.    | Red.       |
| 24  | Carmosin B (R. H.).              | No change.                      | .....      | Purple.                      | .....     | Yellower.                          | Pink.     | No change.    | Pink.      |
| 25  | Fast red D (Bad.)                | Dark violet.                    | Violet.    | Violet.                      | Violet.   | Red brown.                         | Red.      | No change.    | .....      |
| 26  | Amaranth B (Cassella) (mixture). | Violet.                         | .....      | Greenish blue.               | Blue.     | Dark violet.                       | .....     | No change.    | .....      |
| 27  | Amaranth (Sch.).                 | Darker.                         | .....      | Violet.                      | Violet.   | Partly decolorized.                | .....     | No change.    | Red.       |

TABLE III.—*Color reactions of dyed fiber (wool)—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.                         | Concentrated hydrochloric acid.  |                | Concentrated sulphuric acid. |           | 10 per cent caustic soda solution. |           | Ammonia 0.95.       |           |
|-----|--|----------------------------------|----------------|------------------------------|-----------|------------------------------------|-----------|---------------------|-----------|
|     |  | Fiber.                           | Solution.      | Fiber.                       | Solution. | Fiber.                             | Solution. | Fiber.              | Solution. |
| 28  | Archil substitute (R. II.).            | Light magenta.                   | Light magenta. | Darker.                      | Darker.   | Darker.                            | .....     | No change.          | .....     |
| 29  | Archil substitute 3 VN<br>(St. Denis). | Magenta.                         | .....          | Darker.                      | .....     | Darker.                            | .....     | Lilac.              | .....     |
| 30  | Lanafuchsin 6 B (Cassella).            | Rose red.                        | .....          | Deep pink.                   | Red.      | Deep pink.                         | .....     | Nearly decolorized. | .....     |
| 31  | Magenta.                               | Yellow brown.                    | Yellow.        | Dirty violet.                | Yellow.   | Decolorized.                       | .....     | Decolorized.        | .....     |
| 32  | Acid magenta (Bad. and<br>Berlin).     | Nearly or wholly<br>decolorized. | .....          | Yellow.                      | .....     | Decolorized.                       | .....     | Decolorized.        | .....     |
| 33  | Safranin (B. S. S.).                   | Greenish blue.                   | Greenish blue. | Green.                       | .....     | Crimson.                           | .....     | Crimson.            | .....     |
| 34  | Benzopurpurin.                         | Blue.                            | .....          | Blue.                        | .....     | No change.                         | .....     | No change.          | .....     |
| 35  | Congo red.                             | Blue.                            | Colorless.     | Blue.                        | Blue.     | No change.                         | .....     | No change.          | .....     |
| 36  | Eosin (mixture).                       | Yellow.                          | .....          | Yellow.                      | .....     | Yellowish pink.                    | .....     | No change.          | .....     |
| 37  | Eosin A (Bad.).                        | Yellow.                          | .....          | Yellow.                      | .....     | Darker.                            | Pink.     | No change.          | Pink.     |

TABLE III.—*Color reactions of dyed fiber (wool)—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.           | Concentrated hydrochloric acid. |           | Concentrated sulphuric acid. |                | 10 per cent caustic soda solution. |             | Ammonia 0.95. |           |
|-----|--------------------------|---------------------------------|-----------|------------------------------|----------------|------------------------------------|-------------|---------------|-----------|
|     |                          | Fiber.                          | Solution. | Fiber.                       | Solution.      | Fiber.                             | Solution.   | Fiber.        | Solution. |
| 38  | Azo eosin (By.).         | Crimson.                        | Crimson.  | Crimson.                     | Orange.        | Orange.                            | Orange red. | Orange.       | Orange.   |
| 39  | Phloxin (Bad.).          | Yellow.                         | .....     | Orange yellow.               | Orange yellow. | No change.                         | .....       | No change.    | .....     |
| 40  | Rose bengal (Bad.).      | Yellowish.                      | .....     | Orange.                      | .....          | No change.                         | .....       | No change.    | Pink.     |
| 41  | Rhodamin (Bad.).         | Orange.                         | .....     | Yellow.                      | .....          | No change.                         | .....       | No change.    | Pink.     |
| 42  | Pink M (R. II.).         | Pinkish yellow.                 | .....     | Yellowish.                   | .....          | Darker.                            | .....       | No change.    | .....     |
| 43  | Fast pink B (Sch.).      | Yellowish.                      | .....     | Yellow.                      | .....          | Bluer.                             | .....       | No change.    | Pink.     |
| 44  | Erythrosin.              | Orange yellow.                  | .....     | Orange yellow.               | Yellow.        | No change.                         | .....       | No change.    | Pink.     |
| 45  | Tropaeolin O (Cassella). | Orange.                         | Yellow.   | Orange.                      | Yellow.        | Orange red.                        | Orange.     | No change.    | Yellow.   |

TABLE III.—*Color reactions of dyed fiber (wool)—Continued.*

COAL-TAR COLORS—Continued.

[Cir. 63]

| No. | Name of color.                         | Concentrated hydrochloric acid. |           | Concentrated sulphuric acid. |           | 10 per cent caustic soda solution. |            | Ammonia 0.95. |                |
|-----|--|---------------------------------|-----------|------------------------------|-----------|------------------------------------|------------|---------------|----------------|
|     |  | Fiber.                          | Solution. | Fiber.                       | Solution. | Fiber.                             | Solution.  | Fiber.        | Solution.      |
| 46  | Tropeolin OO (Cassella).               | Magenta.                        | Magenta.  | Deep violet.                 | Violet.   | No change.                         | .....      | No change.    | .....          |
| 47  | Orange IV (R. H.).                     | Magenta.                        | Magenta.  | Deep violet.                 | Violet.   | No change.                         | .....      | No change.    | Yellow.        |
| 48  | Methyl orange.                         | Scarlet.                        | Red.      | Brown yellow.                | .....     | No change.                         | Colorless. | No change.    | Orange yellow. |
| 49  | Orange extra (Cassella).               | Crimson.                        | .....     | Crimson.                     | .....     | Orange red.                        | .....      | No change.    | .....          |
| 50  | Orange II (St. Denis).                 | Crimson.                        | Crimson.  | Crimson.                     | Crimson.  | Orange red.                        | Red.       | No change.    | Orange.        |
| 51  | Orange II (By).                        | Scarlet.                        | Red.      | Crimson.                     | .....     | Red orange.                        | Orange.    | No change.    | .....          |
| 52  | Tylenonid orange Y (R. H.). (Mixture.) | Violet.                         | .....     | Magenta.                     | Red.      | No change.                         | .....      | No change.    | .....          |
| 53  | Crocelin orange Y (Sch.).              | redder.                         | Red.      | Darker.                      | Red.      | Orange red.                        | Orange.    | No change.    | .....          |
| 54  | Orange I.                              | Purple.                         | .....     | Purple.                      | .....     | Red.                               | .....      | Red.          | .....          |

TABLE III.—*Color reactions of dyed fiber (wool)—Continued.*  
COAL-TAR COLORS—Continued.

| No. | Name of color.             | Concentrated hydrochloric acid. |           | Concentrated sulphuric acid. |           | 10 per cent caustic soda solution. |           | Ammonia 0.95. |           |
|-----|----------------------------|---------------------------------|-----------|------------------------------|-----------|------------------------------------|-----------|---------------|-----------|
|     |                            | Fiber.                          | Solution. | Fiber.                       | Solution. | Fiber.                             | Solution. | Fiber.        | Solution. |
| 55  | Crocein orange G (By.).    | Orangered.                      | .....     | Orange.                      | .....     | Darker.                            | .....     | No change.    | .....     |
| 56  | Ponceau 4 GB (Berlin)      | Orangered.                      | .....     | Orange.                      | .....     | Little darker.                     | .....     | No change.    | .....     |
| 57  | Orange G (Berlin).         | Darker.                         | .....     | Orange.                      | .....     | Terra cotta.                       | .....     | No change.    | .....     |
| 58  | Orange G (R. H.).          | Crimson.                        | .....     | Crimson.                     | .....     | Red orange.                        | .....     | No change.    | .....     |
| 59  | Orange GG (Cassella).      | Darker.                         | .....     | Orange.                      | .....     | Terra cotta.                       | .....     | No change.    | .....     |
| 60  | Auramine.                  | Decolorized.                    | .....     | Nearly decolorized.          | .....     | No change.                         | .....     | Paler.        | .....     |
| 61  | Naphthol yellow (Bad.).    | Decolorized.                    | .....     | Paler.                       | .....     | No change.                         | Yellow.   | No change.    | Yellow.   |
| 62  | Yellow YM (R. H.).         | Nearly decolorized.             | .....     | Paler.                       | .....     | No change.                         | Yellow.   | No change.    | Yellow.   |
| 63  | Naphthol yellow (Grübler). | Decolorized.                    | .....     | Paler.                       | .....     | No change.                         | Yellow.   | No change.    | Yellow.   |
| 64  | Martius yellow.            | Paler.                          | .....     | Brownish yellow.             | .....     | Deeper.                            | Yellow.   | Deeper.       | Yellow.   |

TABLE III.—*Color reactions of dyed fiber (wool)—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.             | Concentrated hydrochloric acid. |             | Concentrated sulphuric acid. |           | 10 per cent caustic soda solution. |           | Ammonia 0.95. |           |
|-----|----------------------------|---------------------------------|-------------|------------------------------|-----------|------------------------------------|-----------|---------------|-----------|
|     |                            | Fiber.                          | Solution.   | Fiber.                       | Solution. | Fiber.                             | Solution. | Fiber.        | Solution. |
| 65  | Picric acid.               | Decolorized.                    | .....       | Yellowish.                   | .....     | Darker.                            | Yellow.   | No change.    | Yellow.   |
| 66  | Chrysamin.                 | Pale brown.                     | .....       | Crimson.                     | .....     | Red orange.                        | Orange.   | Darker.       | .....     |
| 67  | Fast yellow (Bad.).        | Red.                            | Orange red. | .....                        | .....     | Darker.                            | .....     | No change.    | Yellow.   |
| 68  | Wool yellow T (Sch.).      | No change.                      | Yellow.     | No change.                   | Yellow.   | No change.                         | Yellow.   | No change.    | Yellow.   |
| 69  | Tartrazin (Bad.).          | Darker.                         | .....       | Darker.                      | .....     | No change.                         | Yellow.   | No change.    | Yellow.   |
| 70  | Metanil yellow (Oehler).   | Magenta.                        | Magenta.    | Dark violet.                 | Violet.   | No change.                         | .....     | No change.    | Yellow.   |
| 71  | Brilliant yellow S (Sch.). | Magenta.                        | Magenta.    | Magenta.                     | Magenta.  | Little darker.                     | Yellow.   | No change.    | .....     |
| 72  | "Chinolin yellow" (R. H.). | Darker.                         | .....       | Brownish yellow.             | .....     | Paler.                             | .....     | No change.    | .....     |

TABLE III.—*Color reactions of dyed fiber (wool)*—Continued.  
COAL-TAR COLORS—Continued.

[Cir. 63]

| No. | Name of color.             | Concentrated hydrochloric acid. |            | Concentrated sulphuric acid. |            | 10 per cent caustic soda solution. |           | Ammonia 0.95.       |           |
|-----|----------------------------|---------------------------------|------------|------------------------------|------------|------------------------------------|-----------|---------------------|-----------|
|     |                            | Fiber.                          | Solution.  | Fiber.                       | Solution.  | Fiber.                             | Solution. | Fiber.              | Solution. |
| 73  | Chrysoidin.                | Brown.                          | .....      | Maroon.                      | Yellow.    | No change.                         | .....     | No change.          | .....     |
| 74  | Sudan I.                   | Crimson.                        | .....      | Crimson.                     | .....      | Darker.                            | .....     | No change.          | .....     |
| 75  | Sudan brown (Berlin).      | Blue.                           | .....      | Green.                       | .....      | Darker.                            | .....     | No change.          | .....     |
| 76  | Sudan G.                   | Yellow brown.                   | .....      | Yellow brown.                | .....      | Redder.                            | .....     | Yellow.             | Yellow.   |
| 77  | Malachite green (Berlin).  | Decorolized.                    | Yellowish. | Decorolized.                 | Yellowish. | Decorolized.                       | .....     | Decorolized.        | .....     |
| 78  | Ethyl green (Berlin).      | Decorolized.                    | .....      | Yellowish.                   | .....      | Decorolized.                       | .....     | Decorolized.        | .....     |
| 78  | Sudan III.                 | Purplic or violet.              | .....      | Bluish green.                | .....      | Purplic or violet.                 | .....     | No change.          | .....     |
| 79  | Acid green 780 (Cassella). | Yellow.                         | .....      | Orange.                      | .....      | Decorolized.                       | .....     | Decorolized.        | .....     |
| 80  | Acid green OO (Sch.).      | Yellow.                         | .....      | Orange.                      | .....      | Nearly decolorized.                | .....     | Nearly decolorized. | .....     |

*a* Dyed on silk fiber from dilute alcoholic solution.

TABLE III.—*Color reactions of dyed fiber (wool)—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.                | Concentrated hydrochloric acid. |           |                  | Concentrated sulphuric acid. |               |           | 10 per cent caustic soda solution. |           |        | Ammonia 0.95. |        |           |
|-----|-------------------------------|---------------------------------|-----------|------------------|------------------------------|---------------|-----------|------------------------------------|-----------|--------|---------------|--------|-----------|
|     |                               | Fiber.                          | Solution. | Fiber.           | Solution.                    | Fiber.        | Solution. | Fiber.                             | Solution. | Fiber. | Solution.     | Fiber. | Solution. |
| 81  | Cyanole green 6 G (Cassella). | Orange.                         | .....     | Yellowish.       | .....                        | Darker.       | .....     | No change.                         | .....     | .....  | .....         | .....  | .....     |
| 82  | Naphthol green B (Cassella).  | Yellowish.                      | .....     | Brownish yellow. | .....                        | No change.    | .....     | No change.                         | .....     | .....  | .....         | .....  | .....     |
| 83  | Azo blue (By.).               | Darker.                         | .....     | Greenish blue.   | .....                        | Rose red.     | .....     | Purple.                            | .....     | .....  | .....         | .....  | .....     |
| 84  | Cyanole FF (Cassella).        | Yellow.                         | .....     | Yellowish.       | .....                        | Yellow green. | .....     | No change.                         | .....     | Blue.  | .....         | .....  | .....     |
| 85  | Methylene blue (Bad.).        | Decolorized.                    | .....     | Yellowish.       | .....                        | Decolorized.  | .....     | No change.                         | .....     | .....  | .....         | .....  | .....     |
| 86  | Tetracyanole SF (Cassella).   | Yellow.                         | .....     | Yellowish.       | .....                        | Darker.       | Blue.     | Darker.                            | Blue.     | .....  | .....         | .....  | .....     |
| 87  | Methyl violet DB (Sch.).      | Yellowish.                      | .....     | Yellowish.       | .....                        | Decolorized.  | .....     | Nearly decolorized.                | .....     | .....  | .....         | .....  | .....     |

TABLE III.—*Color reactions of dyed fiber (wool)—Continued.*

## COAL-TAR COLORS—Continued.

| No. | Name of color.                     | Concentrated hydrochloric acid. |           | Concentrated sulphuric acid. |              | 10 per cent caustic soda solution. |           | Ammonia 0.95.       |             |
|-----|------------------------------------|---------------------------------|-----------|------------------------------|--------------|------------------------------------|-----------|---------------------|-------------|
|     |                                    | Fiber.                          | Solution. | Fiber.                       | Solution.    | Fiber.                             | Solution. | Fiber.              | Solution.   |
| 88  | Methylene violet 2 BX<br>(Berlin). | Yellow.                         | .....     | Yellow.                      | .....        | Decolorized.                       | .....     | Nearly decolorized. | .....       |
| 89  | Indigo disulpho-acid.              | Darker.                         | Blue.     | Darker.                      | Violet blue. | Yellow.                            | Yellow.   | Green.              | Green.      |
| 90  | Bismarck brown (Berlin).           | Darker and redder.              | .....     | Browner.                     | .....        | Yellower.                          | .....     | Yellower.           | .....       |
| 91  | Fast brown G (Berlin).             | Violet.                         | .....     | Violet.                      | .....        | Rose.                              | .....     | Rose.               | .....       |
| 92  | Naphthol black BDF<br>(Cassella).  | Greenish blue.                  | .....     | Olive green.                 | .....        | Black.                             | .....     | No change.          | .....       |
| 93  | Naphthol blue black (Cassella).    | Darker                          | .....     | Darker.                      | .....        | Darker.                            | .....     | Green blue.         | Green blue. |

## NATURAL COLORS.

| 94 | Cochineal. | No change. | ..... | Brighter red. | ..... | Magenta. | Magenta. | Crimson. | ..... |
|----|------------|------------|-------|---------------|-------|----------|----------|----------|-------|
|    |            |            |       |               |       |          |          |          |       |

TABLE III.—*Color reactions of dyed fiber (wool)*—Continued.

## NATURAL COLORS—Continued.

| No.<br>[Cir. 63] | Name of color.                        | Concentrated hydrochloric acid. |           |               | Concentrated sulphuric acid. |              |           | 10 per cent caustic soda solution. |           |             | Ammonia 0.95. |             |           |
|------------------|---------------------------------------|---------------------------------|-----------|---------------|------------------------------|--------------|-----------|------------------------------------|-----------|-------------|---------------|-------------|-----------|
|                  |                                       | Fiber.                          | Solution. | Fiber.        | Solution.                    | Fiber.       | Solution. | Fiber.                             | Solution. | Fiber.      | Solution.     | Fiber.      | Solution. |
| 95               | Cudbear.                              | Deep pink.                      | .....     | Dark gray.    | .....                        | Violet.      | .....     | Violet.                            | .....     | Violet.     | .....         | Violet.     | .....     |
| 96               | Archil.                               | Deep pink.                      | .....     | Bluish gray.  | .....                        | Purple.      | .....     | Purple.                            | .....     | Purple.     | .....         | Purple.     | .....     |
| 97               | Litmus.                               | Pink.                           | .....     | Brownish.     | .....                        | Blue.        | .....     | Blue.                              | .....     | Blue.       | .....         | Blue.       | .....     |
| 98               | Azo litmin                            | Pink.                           | .....     | Brownish.     | .....                        | Blue.        | .....     | Blue.                              | .....     | Blue.       | .....         | Blue.       | .....     |
| 101              | Logwood, chrome-mordanted cotton.     | Red.                            | Red.      | Brown.        | .....                        | Black brown. | .....     | Black brown.                       | .....     | Pale brown. | .....         | Pale brown. | .....     |
| 102              | Brazil wood, chrome-mordanted cotton. | Orange red.                     | Red.      | Yellow brown. | .....                        | Maroon.      | .....     | Maroon.                            | .....     | Purple.     | .....         | Maroon.     | .....     |
| 103              | Barwood.                              | Yellow pink.                    | .....     | Yellow brown. | .....                        | Maroon.      | .....     | Maroon.                            | .....     | Blue black. | .....         | Blue black. | .....     |
| 104              | Catechu.                              | Brown.                          | .....     | Dark brown.   | .....                        | Brown.       | .....     | Brown.                             | .....     | Brown.      | .....         | Brown.      | .....     |

TABLE III.—*Color reactions of dyed fiber (wool)*—Continued.

NATURAL COLORS—Continued.

| No. | Name of color.                     | Concentrated hydrochloric acid. |           | Concentrated sulphuric acid.     |            | 10 per cent caustic soda solution. |           | Ammonia 0.95.    |           |
|-----|------------------------------------|---------------------------------|-----------|----------------------------------|------------|------------------------------------|-----------|------------------|-----------|
|     |                                    | Fiber.                          | Solution. | Fiber.                           | Solution.  | Fiber.                             | Solution. | Fiber.           | Solution. |
| 106 | Spanish saffron.                   | Darker.                         | .....     | Olive green, changing to maroon. | .....      | No change.                         | .....     | No change.       | .....     |
| 108 | Quercitron, alum-mordanted cotton. | No change.                      | Yellow.   | .....                            | No change. | Yellow.                            | .....     | No change.       | Yellow.   |
| 109 | Sunae.                             | No change.                      | .....     | Yellow brown.                    | .....      | Brownish yellow.                   | .....     | No change.       | .....     |
| 110 | Anatto.                            | Pale brown.                     | .....     | Green.                           | .....      | No change.                         | .....     | No change.       | .....     |
| 111 | Turmeric.                          | Deep crimson.                   | .....     | Orange brown.                    | .....      | Orange.                            | .....     | Orange.          | .....     |
| 112 | Persian berry extract.             | Darker.                         | .....     | Brownish yellow.                 | .....      | Little darker.                     | .....     | Darker.          | .....     |
| 113 | Fustic extract.                    | Orange yellow.                  | .....     | Yellow brown.                    | .....      | Orange yellow.                     | .....     | Orange yellow.   | .....     |
| 114 | Weld, extract.                     | No change.                      | .....     | Brownish yellow.                 | .....      | Slightly deeper.                   | .....     | Slightly deeper. | .....     |
| 116 | Buckthorn.                         | No change.                      | .....     | Brown yellow.                    | .....      | .....                              | .....     | No change.       | .....     |
| 116 | Kamala.                            | No change.                      | .....     | Darker.                          | .....      | Brown orange.                      | .....     | No change.       | .....     |
| 122 | Poke berry.                        | Little change.                  | .....     | Yellow brown.                    | .....      | Yellow.                            | .....     | Yellow.          | .....     |
| 126 | Carthamin, on cotton.              | Orange.                         | .....     | Brown.                           | .....      | Yellow brown.                      | .....     | Pinkish yellow.  | .....     |

[Cir. 63]

TABLE IV.—APPEARANCE AND REACTIONS OF COLORS IN AQUEOUS SOLUTION AND WITH CONCENTRATED SULPHURIC ACID.

| No. | Name of color.             | Add to aqueous solution of color—      |  | Dry color + concentrated sulphuric acid. |  |
|-----|----------------------------|--|--|--|--|
|     |                            | Hydrochloric acid, 1.10. (5-10 drops.) | 10 per cent sodium hydrate solution. (5-10 drops.) | Ammonia, 0.95. (5-10 drops.)             | Zinc dust + HCl and expose to air on filter paper. |
| 1   | Ponceau red (Grübler).     | Orange red.                            | Yellower.  | No change.                               | Color not restored: Orange red.                    |
| 2   | Ponceau 6 R (M. L. B.).    | Pink.                                  | No change.   | Dirty yellow.                            | Paler. Color not restored. Purple.                 |
| 3   | Scarlet 6 R (M. L. B.).    | Pink.                                  | No change.   | Dirty yellow.                            | Paler. Color not restored. Purple.                 |
| 4   | New coccin (Berlin).       | Pink.                                  | No change.   | Dirty yellow.                            | Paler. Color not restored. Magenta.                |
| 5   | Cochineal red A (Bad.).    | Yellowish pink.                        | No change.   | Dirty yellow.                            | Paler. Color not restored. Magenta.                |
| 6   | Ponceau 4 RB (Berlin).     | Pink.                                  | No change.   | Paler and bluer.                         | No change. Color not restored. Dark blue.          |
| 7   | Crocein scarlet 3 B (By.). | Pink.                                  | No change.   | Purplish blue.                           | No change. Color not restored. Dark blue.          |
| 8   | Crocein scarlet 7 B (By.). | Pink.                                  | No change.   | Bluer.                                   | No change. Color not restored. Dark blue.          |
| 9   | Fast ponceau B (Bad.).     | Red orange.                            | No change.   | Purple.                                  | No change. Color not restored. Dark bluish-green.  |

TABLE IV.—*Appearance and reactions of colors in aqueous solution and with concentrated sulphuric acid—Continued.*

| No. | Name of color.   | Add to aqueous solution of color—      |  |                              | Dry color + concentrated sulphuric acid.            |                  |
|-----|--|--|--|------------------------------|---|------------------|
|     |  | Hydrochloric acid, 1.10. (5-10 drops.) | 10 per cent sodium hydrate solution. (5-10 drops.)   | Ammonia, 0.95. (5-10 drops.) | Zinc dust + HCl, and expose to air on filter paper. | Before dilution. |
| 10  | Biebrich fast scarlet O (Kalle).                           | Cherry red.                            | Slight excess HCl no change; large excess HCl violet.  | Crimson.                     | Color not restored.                                 | Dark blue.       |
| 11  | Biebrich croetin scarlet O (Kalle).                        | Orange.                                | Slight excess HCl darker; large excess HCl lilac.  | Magenta brown.               | No change.  | Dark blue.       |
| 12  | Biebrich croetin scarlet OO (Kalle).                       | Orange red.                            | No change; large excess HCl, magenta solution; brown precipitate after some time.            | Crimson.                     | No change.  | Dark blue.       |
| 13  | Biebrich brilliant crocein scarlet O (Kalle).              | Orange.                                | Slight excess HCl no change; large excess HCl gives lilac, then blue with brown precipitate. | Brown.                       | Orange brown.                                       | Magenta.         |
| 14  | Biebrich brilliant crocein scarlet O <sub>N</sub> (Kalle). | Red orange.                            | No change; large excess HCl gives magenta solution and brown precipitate.                    | Orange brown.                | Color not restored.                                 | Magenta.         |
| 15  | Scarlet RD (R. H.). (Mixture.)                             | Red orange.                            | No change.   | Darker.                      | Color not restored.                                 | Crimson.         |
| 16  | Ponceau 2 R (Sch.).  | Orange.                                | No change.   | Brownish yellow.             | Color not restored.                                 | Cherry red.      |
| 17  | Ponceau 3 R (Sch.).  | Red orange.                            | No change.   | Brownish yellow.             | Color not restored.                                 | Cherry red.      |
| 18  | Brilliant cochineal 2 R (Cassella).                        | Orange red.                            | No change.   | Brownish yellow.             | Color not restored.                                 | Crimson.         |
|     |  |  |  |                              |   | Orange red.      |

TABLE IV.—*Appearance and reactions of colors in aqueous solution and with concentrated sulphuric acid—Continued.*

| No. | Name of color.                    | Color of aqueous solution as observed in $\frac{3}{4}$ " test tube. | Add to aqueous solution of color—                     |   | Dry color + concentrated sulphuric acid.                      |
|-----|-----------------------------------|---|---|---|---|
|     |                                   |   | 10 per cent sodium hydrate solution.<br>(5-10 drops.) | Zinc dust + HCl, and expose to air on filter paper. |   |
| 19  | Fast red A (Bad.).                | Orange red.   | Brown yellow, red precipitate.                        | No change.  | Purple, then yellow brown precipitate.                        |
| 20  | Fast red B (Bad.).                | Magenta.  | No change.  | Pinkish yellow.                                     | Purple, then maroon precipitate, then clear magenta solution. |
| 21  | Bordeaux B (Berlin).              | Magenta.  | No change.  | Red orange.   | Purple, then magenta.   |
| 22  | Fast red C (Bad.).                | Orange red.   | Redder.   | No change.  | Dark blue.  |
| 23  | Azo rubin (Sch.).                 | Orange red.   | Redder.   | No change.  | Dark blue.  |
| 24  | Carmosin B (R. H.).               | Orange red.   | Magenta and strongly brown precipitate.               | No change.  | Dark red precipitate.   |
| 25  | Fast red D (Bad.).                | Orange pink.  | Brownish yellow.                                      | No change.  | Purple.   |
| 26  | Amaranth B (Cassella). (Mixture). | Crimson.  | Bluer.  | Purple.   | Dark blue.  |

TABLE IV.—*Appearance and reactions of colors in aqueous solution and with concentrated sulphuric acid—Continued.*

| [Cir. 63] | Name of color.                      | Color of aqueous solution as observed in $\frac{3}{4}$ " test tube. | Add to aqueous solution of color—      | Dry color+concentrated sulphuric acid.              |
|-----------|-------------------------------------|---|--|---|
| 27        | Amaranth (Sch.).                    | Light magenta.  | Hydrochloric acid, 1.10. (5-10 drops.) | 10 per cent sodium hydrate solution. (5-10 drops.)  |
| 28        | Archil substitute (R. H.).          | Brown orange.   | Slightly bluer.                        | No change.  |
| 29        | Archil substitute 3 VN (St. Denis). | Orange pink.  | Red brown precipitate.                 | Red brown precipitate.                              |
| 30        | Lanafuchsin 6 B (Cassella).         | Magenta.  | Magenta.                               | Paler.  |
| 31        | Magenta.                            | Crimson.  | No change.                             | Pale yellowish pink.                                |
| 32        | Achi magenta (Bad. and Berlin).     | Crimson.  | Brownish yellow.                       | Pale yellowish pink.                                |
| 33        | Safranin (B. S. S.).                | Red.  | Little darker.                         | Color gradually fades away.                         |
| 34        | Benzopurpurin.                      | Orange red.   | Magenta.                               | Color not restored.                                 |
| 35        | Congo red.                          | Orange red.   | Dark blue and precipitate.             | No change.  |
|           |                                     |   |  | Zinc dust + HCl, and expose to air on filter paper. |
|           |                                     |   |  | Before dilution.                                    |
|           |                                     |   |  | After dilution.                                     |
|           |                                     |   |  | Color not restored.                                 |
|           |                                     |   |  | Purple-violet.                                      |
|           |                                     |   |  | Magenta, then crimson.                              |
|           |                                     |   |  | No change.  |
|           |                                     |   |  | Crimson.  |
|           |                                     |   |  | Magenta.  |
|           |                                     |   |  | Orange red.   |
|           |                                     |   |  | Light crimson.                                      |
|           |                                     |   |  | Yellow.   |
|           |                                     |   |  | Magenta.  |
|           |                                     |   |  | Blue green, blue violet, and magenta.               |
|           |                                     |   |  | Dark blue.  |
|           |                                     |   |  | Blue precipitate.                                   |
|           |                                     |   |  | Dark blue.  |

TABLE IV.—*Appearance and reactions of colors in aqueous solution and with concentrated sulphuric acid—Continued.*

| No. | Name of color.              | Add to aqueous solution of color—      |   |                              |   | Dry color+concentrated sulphuric acid. |
|-----|-----------------------------|--|---|------------------------------|---|--|
|     |                             | Hydrochloric acid, 1.10. (5-10 drops.) | 10 per cent sodium hydrate solution. (5-10 drops.)  | Ammonia, 0.95. (5-10 drops.) | Zinc dust + $\text{HCl}$ , and expose to air on filter paper. |  |
| 36  | Eosin (mixture).            | Yellow, orange precipitate.            | No change.  | No change.                   | Color not restored.   | Yellow.                                |
| 37  | Eosin A (Bad.).             | Yellow, orange precipitate.            | No change.  | No change.                   | Color not restored.   | Yellow.                                |
| 38  | Azo-eosin (By.).            | Pink.                                  | No change.  | Brownish yellow.             | Color not restored.   | Crimson.                               |
| 39  | Phloxin (Bad.).             | Pink, fluorescent.                     | Decolorized, orange precipitate.                    | No change.                   | Color not restored.   | Orange yellow.                         |
| 40  | Rose bengal (Bad.).         | Pink.                                  | Decolorized, red precipitate.                       | No change.                   | Color not restored.   | Orange.                                |
| 41  | Rhodamin (Bad.).            | Pale magenta, fluorescent.             | Paler.  | No change.                   | Color not restored.   | Yellow.                                |
| 42  | Pink M (R. H.).             | Pale magenta, fluorescent.             | Pink, less fluorescent.                             | No change.                   | Color slowly restored.  | Yellow.                                |
| 43  | Fast pink B (Sch.).         | Pale magenta, fluorescent.             | Pale pink, not fluorescent.                         | No change.                   | Color not restored.   | Yellow.                                |
| 44  | Erythrosin.                 | Yellowish pink.                        | Yellower, slightly cloudy, then orange precipitate. | Pink.                        | No change.  | .....                                  |
| 45  | Tropaneolin O (Cassella).   | Orange yellow.                         | No change.  | Red orange.                  | Color not restored.   | Orange.                                |
| 46  | Tropaneolin O O (Cassella). | Yellow.                                | Magenta.  | Little darker, turbid.       | Color not restored.   | Magenta.                               |

TABLE IV.—*Appearance and reactions of colors in aqueous solution and with concentrated sulphuric acid—Continued.*

| No. | Name of color.                       | Color of aqueous solution as observed in $\frac{1}{4}$ " test tube. | Add to aqueous solution of color—         |  |                              | Dry color + concentrated sulphuric acid.            |
|-----|--------------------------------------|---|---|--|------------------------------|---|
|     |                                      |   | Hydrochloric acid, 1:10. (5-10 drops.)    | 10 per cent sodium hydrate solution. (5-10 drops.) | Ammonia, 0.95. (5-10 drops.) |   |
| 47  | Orange IV (R. H.).                   | Pale orange (not very soluble).                                     | Magenta.                                  | No change.   | No change.                   | Zinc dust + HCl, and expose to air on filter paper. |
| 48  | Methyl orange.                       | Orange.   | Pink.                                     | No change.   | No change.                   | Before dilution.                                    |
| 49  | Orange extra (Cassella).             | Orange.   | No change.                                | Pink.  | Redder.                      | After dilution.                                     |
| 50  | Orange II (St. Denis).               | Orange.   | Orange, stringy precipitate. <sup>a</sup> | Orange red.  | Red orange.                  | Magenta.  |
| 51  | Orange II (By.).                     | Orange.   | No change.                                | Orange red.  | Orange red.                  | Crimson.  |
| 52  | Tyemond orange Y (R. H.). (Mixture). | Orange.   | Brown.                                    | Yellow.  | No change.                   | Orange solution and brown precipitate.              |
| 53  | Crocein orange Y (Sch.).             | Orange yellow.  | No change.                                | Darker.  | Color not restored.          | Violet precipitate.                                 |
| 54  | Orange I.                            | Orange.   | Redder; large excess HCl = magenta.       | Orange red.  | Color not restored.          | Paler.  |
|     |                                      |   |   |  |                              | Crimson, then orange.                               |

<sup>a</sup> No change; stringy, brown precipitate in more concentrated solution.

TABLE IV.—*Appearance and reactions of colors in aqueous solution and with concentrated sulphuric acid—Continued.*

| No. | Name of color.             | Color of aqueous solution as observed in $\frac{1}{4}$ " test tube. | Add to aqueous solution of color—                     |   | Dry color + concentrated sulphuric acid. |  |
|-----|----------------------------|---|---|---|--|--|
|     |                            |   | 10 per cent sodium hydrate solution.<br>(5-10 drops.) | Zinc dust + HCl, and expose to air on filter paper. | Before dilution.                         | After dilution.                          |
| 55  | Crocein orange G (By.).    | Orange.   | No change.  | Redder.   | Brownish orange.                         | Orange red, then orange.                 |
| 56  | Ponceau 4 GB.              | Orange.   | No change.  | Redder.   | Color not restored.                      | Orange-red, then orange.                 |
| 57  | Orange G (Berlin).         | Orange.   | No change.  | Pink.   | No change.                               | Orange red, then orange.                 |
| 58  | Orange G (R. II.).         | Orange.   | No change.  | Pink or orange red.                                 | Red orange.                              | Crimson, then orange, and a precipitate. |
| 59  | Orange GG (Cassella).      | Orange.   | No change.  | Pink.   | No change.                               | Orange yellow.                           |
| 60  | Auramine.                  | Yellow.   | No change.  | Decolorized; white precipitate.                     | Color not restored.                      | Colorless.                               |
| 61  | Naphthol yellow (Bad.).    | Yellow.   | Decolorized, clear solution.                          | No change.  | Color not restored.                      | Yellow.                                  |
| 62  | Yellow YM (R. H.).         | Yellow.   | Nearly decolorized.                                   | No change.  | Slowly turns red.                        | Yellow.                                  |
| 63  | Naphthol yellow (grübler). | Yellow.   | Decolorized and cloudy.                               | No change.  | Color not restored.                      | Orange yellow.                           |

TABLE IV.—*Appearance and reactions of colors in aqueous solution and with concentrated sulphuric acid—Continued.*

| No.<br>[Cir. 63] | Name of color.             | Color of aqueous solution as observed in 4 <sup>3/4</sup> test tube. | Add to aqueous solution of color—                  |   |                                 | Dry color + concentrated sulphuric acid.            |  |                 |
|------------------|----------------------------|--|--|---|---------------------------------|---|--|-----------------|
|                  |                            |  | Hydrochloric acid, 1:10.<br>(5-10 drops.)          | 10 per cent sodium hydrate solution.<br>(5-10 drops.) | Ammonia, 0.95.<br>(3-10 drops.) | Zinc dust + HCl, and expose to air on filter paper. | Before dilution.                                       | After dilution. |
| 64               | Martius yellow.            | Yellow.  | Paler.   | No change.  | No change.                      | Orange yellow.                                      | Straw yellow.  |                 |
| 65               | Pteric acid.               | Yellow.  | Yellow and crystal precipitate.                    | Darker.   | No change.                      | Colorless.  | Yellow.  |                 |
| 66               | Chrysamin.                 | Yellow.  | Paler and orange precipitate.                      | Red orange.   | Orange.                         | Crimson.  | Darker, then colorless solution and brown precipitate. |                 |
| 67               | Fast yellow (Bad.).        | Yellow.  | Orange.  | No change.  | No change.                      | Orange.   | Orange red.  |                 |
| 68               | Wool yellow T (Sch.).      | Yellow.  | No change.   | No change.  | No change.                      | Yellow.   | Yellow.  |                 |
| 69               | Tartrazin (Bad.).          | Yellow.  | No change.   | No change.  | No change.                      | Yellow.   | Yellow.  |                 |
| 70               | Metanil yellow (Oleifer).  | Yellow.  | Magenta.   | No change.  | No change.                      | Purple.   | Magenta.   |                 |
| 71               | Brilliant yellow S (Sch.). | Yellow.  | Darker; more HCl = orange red; more HCl = magenta. | No change.  | No change.                      | Crimson or magenta.                                 | Magenta, then orange red, orange and yellow.           |                 |

TABLE IV.—*Appearance and reactions of colors in aqueous solution and with concentrated sulphuric acid—Continued.*

| [Cir. 63] |                                 | Color of aqueous solution as observed in $\frac{1}{4}$ " test tube. | Add to aqueous solution of color—                       |  | Dry color + concentrated sulphuric acid. |   |                          |
|-----------|---------------------------------|---|---|--|--|---|--------------------------|
| No.       | Name of color                   |   | Hydrochloric acid, 1:10, (5-10 drops.)                  | sodium hydrate solution, (5-10 drops.) | - Ammonia, 0.95, (5-10 drops.)           | Zinc dust + HCl, and expose to air on filter paper. | Before dilution.         |
| 72        | Chinolin yellow (R. H.).        | Yellow.   | No change.  | No change.                             | No change.                               | Color not restored.                                 | Orange.                  |
| 73        | Chrysoidin.                     | Yellow.   | Orange.   | No change.                             | No change.                               | Color not restored.                                 | Brownish yellow.         |
| a74       | Sudan I.                        | Orange yellow.  | No change.  | Redder.                                | No change.                               | .....   | Bright red.              |
| a75       | Sudan brown (Berlin).           | Orange red.   | Deep crimson.   | Darker.                                | Darker.                                  | .....   | Dark blue.               |
| a76       | Sudan G.                        | Orange.   | No change.  | Brownish red.                          | Brownish yellow.                         | .....   | Dark reddish brown.      |
| 77        | Malachite-green (Berlin).       | Blue.   | Orange.   | Decolorized.                           | Decolorized.                             | Color not restored.                                 | Yellow.                  |
| 78        | Ethyl green (Berlin).           | Green.  | Olive-green. Orange-yellow on adding a little more HCl. | Decolorized by large excess.           | Decolorized by large excess.             | Color not restored.                                 | Red-orange, then orange. |
| a78       | Sudan III (prepared by author). | Red orange.   | No change.  | Purple.                                | No change.                               | Color not restored.                                 | Greenish blue.           |
| 79        | Acid green 780 (Cassella).      | Green.  | Olive-green; more HCl = orange.                         | Decolorized by large excess.           | Decolorized by large excess.             | Color not restored.                                 | Orange-yellow.           |

<sup>a</sup> Tests made on alcoholic solution of color; color insoluble in water.

TABLE IV.—*Appearance and reactions of colors in aqueous solution and with concentrated sulphuric acid*—Continued.

| No. | Name of color.                  | Add to aqueous solution of color—                                   |  |   | Dry color + concentrated sulphuric acid.      |   |
|-----|---------------------------------|---|--|---|---|---|
|     |                                 | Color of aqueous solution as observed in $\frac{1}{4}$ " test tube. | Hydrochloric acid, 1.10. (5-10 drops.) | 10 per cent. sodium hydrate solution. (5-10 drops.)   | Ammonia, 0.95. (5-10 drops.)                  | Zinc dust + HCl, and expose to air on filter paper. |
| 80  | Acid green 00 (Seh.).           | Blue-green.   | Yellowish-green to greenish-yellow.    | Partly decolorized.                                   | Partly decolorized.                           | Orange-yellow.                                      |
| 81  | Cyanole green 6 G (Cassella).   | Blue-green.   | Olive-green; more HCl=orange.          | Dark blue.  | Color not restored.                           | Orange.   |
| 82  | Naphtholgreen B (Cassella).     | Green.  | Paler.                                 | No change.  | Color not restored.                           | Orange.   |
| 83  | Azo blue (By.).                 | Purple.   | Dark precipitate; purple solution.     | Vale magenta.   | No change.                                    | Yellow.   |
| 84  | Cyanole FF (Cassella).          | Purplish-blue.  | Greenish-yellow.                       | Bluish-green by transmitted light; pink by reflected. | In large excess gradually turns pale magenta. | Deep blue.  |
| 85  | Methylene blue (Bad.).          | Blue.   | No change.                             | No change.  | Color not restored.                           | Orange-yellow.                                      |
| 86  | Tetracyanole SF (Cassella).     | Blue.   | Yellow.                                | No change.  | Color restored.                               | Blue.   |
| 87  | Methyl violet DB (Seh.).        | Violet.   | Yellow.                                | Magenta.  | No change.                                    | Orange.   |
| 88  | Methylene violet 2 BX (Berlin). | Violet.   | Greenish-blue; more HCl=yellow-green.  | Gradually turns pink.                                 | Gradually grows paler.                        | Brown-orange, then blue.                            |
|     |                                 |   |  |   |   | Yellow; copious dilution=pale green and then blue.  |

TABLE IV.—*Appearance and reactions of colors in aqueous solution and with concentrated sulphuric acid—Continued.*

| No. | Name of color.                  | Add to aqueous solution of color—                                   |  |  | Dry color + concentrated sulphuric acid.                                |
|-----|---------------------------------|---|--|--|---|
|     |                                 | Color of aqueous solution as observed in $\frac{1}{4}$ " test tube. | Hydrochloric acid, 1.10. (5-10 drops.) | 10 per cent sodium hydrate solution. (5-10 drops.) |   |
| 89  | Indigo disulpho acid.           | Deep blue.  | No change.                             | Green; more NaOH = yellow.                         | Before dilution.<br>Zinc dust + HCl, and expose to air on filter paper. |
| 90  | Bismarck brown (Berlin).        | Yellow.   | Orange.                                | No change.   | After dilution.<br>Dark violet blue.                                    |
| 91  | Fast brown G (Berlin).          | Brownish-red.   | Paler solution and violet precipitate. | Magenta.   | Blue.   |
| 92  | Naphthol black BDF (Cassella).  | Deep magenta.   | Blue.                                  | Purplish-blue.                                     | Color restored.   |
| 93  | Naphthol blue-black (Cassella). | Deep blue.  | Blue solution and precipitate.         | No change.   | Color restored.   |
| 94  | Cochineal.                      | Orange red.   | Orange yellow.                         | Magenta.   | Color restored.   |
| 95  | Cudbear.                        | Lilac.  | Yellowish pink.                        | Purple.  | Purple.   |
| 96  | Archil.                         | Deep lilac.   | Yellowish pink.                        | Purple.  | Purple.   |

TABLE IV.—*Appearance and reactions of colors in aqueous solution and with concentrated sulphuric acid*—Continued.

| No.<br>[Cir. 63] | Name of color.    | Color of aqueous solution as observed in $\frac{1}{4}$ " test tube. | Add to aqueous solution of color—                   |  |   | Dry color + concentrated sulphuric acid.                                    |
|------------------|-------------------|---|---|--|---|---|
|                  |                   |   | Hydrochloric acid, 1.10. (5-10 drops.)              | 10 per cent sodium hydrate solution. (5-10 drops.) | Ammonia, 0.95. (5-10 drops.)  |   |
| 97               | Litmus.           | Blue.   | Pink.   | No change.   | No change.  | Zinc dust + HCl, and expose to air on filter paper.<br>Before dilution.     |
| 98               | Azo litmin.       | Dark crimson.   | Orange red.   | Purple.  | Purple.   | Orange red, then pink.<br>After dilution.                                   |
| 101              | Logwood.          | Brownish yellow.  | Orange.   | Dark brown.  | Color not restored.   | Paler.  |
| 102              | Brazil wood.      | Red orange, slight fluorescence.                                    | Orange, not fluorescent.                            | Crimson.   | Color restored.   | Yellow brown.   |
| 103              | Barwood.          | Insoluble.  | Color precipitated on acidifying alkaline solution. | NaOH solution = deep brown red.                    | NaOH solution + Zn dust = decolorized; on exposure = pinkish, then colorless. | Brown yellow, fluorescent.<br>Yellow, not fluorescent.<br>Pink.             |
| 104              | Catelu (E and A). | Yellow brown.   | Yaler, cloudy.                                      | Dark orange brown.                                 | No change.  | Brownish red.<br>Paler.   |
| 106              | Spanish saffron.  | Yellow.   | No change.  | Yaler.   | Color not restored.   | Blue, then purple, maroon, and red-brown.<br>Yellow, then nearly colorless. |

TABLE IV.—*Appearance and reactions of colors in aqueous solution and with concentrated sulphuric acid—Continued.*

| [Cir. 63]        | Name of color.         | Color of aqueous solution as observed in $\frac{3}{4}$ " test tube. | Add to aqueous solution of color—                      | Dry color + concentrated sulphuric acid.            |
|------------------|------------------------|---|--|---|
| 108              | Quercitron.            | Brownish-yellow.  | Hydrochloric acid, 1.10. (5-10 drops.)                 | 10 per cent sodium hydrate solution. (5-10 drops.)  |
| 109              | Sumac.                 | Dirty yellow.   | Slightly redder.                                       | Ammonia, 0.95. (5-10 drops.)                        |
| 110              | Annatto.               | Yellow in alkaline solution.  | No change.   | Zinc dust + HCl, and expose to air on filter paper. |
| 111              | Turneric.              | Yellow in alkaline solution.  | Paler.   | Before dilution.                                    |
| 112              | Persian berry extract. | Yellow.   | No change.   | After dilution.                                     |
| 113              | Fustic extract.        | Yellow.   | No change.   |   |
| 114              | Weld extract.          | Yellow.   | Paler.   |   |
| 116              | Buckthorn.             | Yellow.   | No change.   |   |
| 116 <sup>2</sup> | Kamala.                | Yellow.   | Dilute alcohol solution of color—<br>Paler and cloudy. | Zinc dust = orange. Original color not restored.    |
| 122              | Pokeberry.             | Crimson.  | Magenta.   | Color not restored.                                 |
|                  |                        |   | Orange-yellow.   | Magenta turning orange brown.                       |
|                  |                        |   | Orange brown.  | Brown.  |

## NOTES ON THE ANALYTICAL SCHEME.

In the preparation of the analytical scheme, the strength of aqueous solutions of coloring matters is approximately 0.01 per cent in the case of coal-tar colors and 0.1 per cent in the case of natural coloring matters.

The following reagents are used and of the strength described, unless otherwise specified:

*Tannin reagent.* As recommended by Weingartner, 10 grams each of tannic acid and sodium acetate in 100 cc of water.

*Hydrochloric acid.* Mix equal volumes of concentrated acid and water.

*Sodium hydrate solution.* Ten grams in 100 cc of water.

*Ammonia solution.* Approximately 10 per cent  $\text{NH}_3$  in water.

*Lead subacetate solution.* Specific gravity 1.25. (See Chemistry Bulletin 107, p. 40.)

*Normal lead acetate solution.* Ten grams in 100 cc of water.

Reactions in aqueous or alcoholic solution are carried out by adding to 10 cc of color solution 5 to 10 drops of reagent.

Unless otherwise noted, each test is to be made on a part of the original color solution and not on the solution used for the previous test.

To determine whether a large amount or almost no color is extracted by immiscible solvents is not always very easy by simple inspection, and it is then best to separate the immiscible solvent from the aqueous layer, filter the former, and evaporate it on the water bath with the addition of water if necessary, as in the case of amyl alcohol. Take up the color in water, make slightly acid or alkaline, according to whether the aqueous layer was acid or alkaline, and compare with the latter. Any considerable amount of color will then be more readily evident, and the dye could also be fixed on wool, which it should color strongly.

If the solution is decolorized by acid or alkali when shaking with an immiscible solvent, it is necessary to separate the two layers carefully and neutralize both in order to find the relative proportion of color in each layer.

In all cases it is advisable, after using the analytical scheme for the identification of a color, to confirm its identity further by applying the appropriate tests as given in Tables I to IV. Many special tests for certain colors will also be found in Allen, loc. cit.; Girard, Analyse des matières alimentaires, etc.; Circular 25 and Bulletin 107, Revised, Bureau of Chemistry; and other works.

Acknowledgment is made of the assistance of F. F. Flanders in the testing of the analytical scheme and of valuable suggestions from B. C. Hesse, New York City, and R. F. Hare, Agricultural College, New Mexico.

(Confirm by tests given in Tables I to IV.)

## I. GREEN COAL-TAR COLORS.

[Mixed blue and yellow generally detected by spot test on filter paper or by fractional dyeing.]

## I. To aqueous 0.01 per cent solution of color add tannin reagent.

A. No precipitate. Add 10 per cent NaOH solution to aqueous color solution.

- a. Gradually decolorized.....*Acid green* (S. & J. 435)
- .....*Cyanole green G*
- b. Dark blue.....*Naphthol green B* (S. & J. 398)
- c. No change.....*Ethyl green*

B. Precipitate. Acidify aqueous solution with HCl and extract with equal volume of ethyl acetate.

- a. Color all extracted.....*Malachite green* (S. & J. 427)
- b. About one-half color extracted.....

## II. BLUE OR VIOLET COLORS.

## I. Insoluble in cold water. Treat with 50 per cent alcohol.

- A. INSOLUBLE.....*Indigo* (S. & J. 689)
- B. SOLUBLE.....*Litmus*

## II. Soluble in cold water. Add tannin reagent to 0.01 per cent aqueous solution.

A. No precipitate. Treat with zinc dust + HCl till decolorized, then filter.

- a. Color of filtrate quickly restored.....*Indigo disulpho-acid* (S. & J. 692)
- b. Color not soon restored in filtrate. To aqueous solution add NaOH solution.
  - 1. Solution blue green by transmitted light, pink by reflected light.....*Cyanole FF* (S. & J. 439)
  - 2. No change.....*Tetracyanole SF* (S. & J. 440)
  - 3. Pale magenta.....*Azo blue* (S. & J. 287)

B. PRECIPITATE. Aqueous solution + 10 per cent NaOH.

- a. Solution magenta.
  - 1. Aqueous solution + HCl = yellow.....*Methyl violet* (S. & J. 451)
  - 2. Aqueous solution + HCl = green.....*Methylene violet* (S. & J. 585)
- b. Solution; no change.....*Methylene blue* (S. & J. 650)

## III. ORANGE AND YELLOW COLORS.

## I. Soluble in cold water. To aqueous solution add tannin reagent.

A. No precipitate. Apply double-dyeing test to aqueous color solution.

a. Wool dyed. To aqueous solution add dilute HCl.

1. Solution changes from yellow to orange..... *Fast yellow* (S. & J. 8)2. Pale yellow or white precipitate. Boil aqueous solution with strong solution of KCN..... *Naphthol yellow* (S. & J. 3)a. Yellow brown solution..... *Victoria yellow* (S. & J. 2)

β. Wine-red solution. To aqueous solution add dilute HCl, allow to stand one-half hour, and filter.

Filtrate colorless..... *Picric acid* (S. & J. 1)3. Solution almost or quite decolorized. Aqueous solution acidified slightly with HCl and shaken with equal volume of ether; two layers separated and ether layer washed twice with 5 to 10 cc water; to ether layer is added an equal volume of very dilute NH<sub>4</sub>OH; shake and allow to separate.α. Aqueous layer bright yellow..... *Naphthol yellow* (S. & J. 3)β. Aqueous layer uncolored..... *Naphthol yellow S* (S. & J. 4)4. Orange brown precipitate..... *Chrysamine* (S. & J. 220 or 269)

5. No change. To aqueous solution add NaOH solution.

α. Solution remains yellow. Treat dry color with acetic ether.

1a. Color insoluble..... *Tartrazine* (S. & J. 94)2a. Color quite soluble..... *Quinoline yellow* (S. & J. 667?)β. Solution becomes redder. Treat dry color with concentrated H<sub>2</sub>SO<sub>4</sub>.1a. Crimson or magenta solution..... *Orange II* (S. & J. 86)2a. Orange solution. To aqueous solution add 10 per cent BaCl<sub>2</sub> solution and allow to stand a minute.1b. Orange precipitate..... *Ponceau 4 GB* (S. & J. 13)2b. No colored precipitate (possibly a precipitate of BaSO<sub>4</sub> insoluble in HCl).Dry color brown orange. Aqueous solution + 10 per cent lead subacetate solution; solution turns orange red and orange red precipitate slowly forms..... *Tropaxolin O* (S. & J. 84)Dry color bright red. Aqueous solution + 10 per cent lead subacetate; no change or slight turbidity only..... *Orange G* (S. & J. 14)

6. Crimson or red. To aqueous solution add NaOH solution.

    α. No change in color; pale glistening precipitate. Dry color + concentrated  $H_2SO_4$ .  
        Purple or violet solution.....  
        Brown solution.....

    β. Much redder.  
        γ. Little or no change and no precipitate. Dry color + concentrated  $H_2SO_4$ .  
            1. Brown solution.....  
            2. Crimson or magenta solution.....  
            3. Purple or violet solution. To 10 cc aqueous solution add about 20 drops NaOH solution.  
                α. Colorless glistening precipitate at once or on standing a few minutes.....  
                β. No change.....

    β. Wool not dyed. To aqueous solution add dilute  $NH_4OH$ .

        1. No change. Dry color + concentrated  $H_2SO_4$  = blue or greenish blue.....  
        2. Darker. Shake aqueous solution with equal volume of acetic ether.

            α. No color extracted. Aqueous solution + 10 per cent  $FeCl_3$  solution, yellow brown solution, no precipitate.....  
            β. Considerable color extracted by acetic ether. To aqueous solution add 10 per cent solution normal lead acetate.

                1. Solution turns bright yellow, no precipitate.....  
                2. Brownish precipitate. Add to aqueous solution 10 per cent alum solution.

                    α. Solution yellow; no precipitate.....  
                    β. Turbidity which is cleared up by a few drops of acetic acid and solution then has decided green fluorescence.....

    γ. Buckthorn (S. & J. 700)

    δ. Quercitron (S. & J. 699)

    ε. Fustic (S. & J. 698)

B. COLORED PRECIPITATE. To color solution add NaOH solution.

    a. Solution decolorized and white precipitate of base. On shaking alkaline solution with ether, solution becomes clear and ether layer turns yellow on adding drop of acetic acid.....  
        α. Auramine (S. & J. 425 or 426)

    b. Yellow or orange precipitate. On shaking alkaline solution with ether, solution becomes clear and color passes mostly into ether layer, which is orange yellow.....  
        α. Chrysoidine (S. & J. 18?)  
        β. Thioflavine

## III. ORANGE AND YELLOW COLORS—Continued.

II. **Insoluble in cold water.** Treat with 95 per cent alcohol.

*A. SOLUBLE.* To alcoholic solution add HCl.

- 1. Crimson or pink.....
- 2. No change or paler. Treat alcoholic solution with zinc dust and a few drops of acetic acid and shake for about half a minute and filter.

*α.* Filtrate colorless. Dry color and concentrated  $H_2SO_4$ .

- Reddish brown.....
- Bright red.....

*β.* Not decolorized or only partially so. (Distinguish and identify by usual tests.)

*B. INSOLUBLE.* Treat with boiling water.

- Soluble.....
- Insoluble.....

(Identify metallic base by qualitative analysis of ash. Identify coloring matter by dissolving lake in acid and extracting with immiscible solvent or by fixing on fiber.)

## IV. RED COLORS.

## I. Soluble in cold water.

*A. DILUTE AQUEOUS SOLUTION FLUORESCENT.* Apply double dyeing test of Sostegni and Carpentieri (Bureau of Chemistry Bul. 107, revised, p. 190).

- a.* Fiber not dyed.....
- b.* Fiber dyed. Add to aqueous solution a few drops tannin reagent.
  - 1. Colored precipitate.....
  - 2. No precipitate. Prepare a dilute solution of color in 95 per cent alcohol.

*α.* Solution has green fluorescence.....  
*β.* Solution has yellow or orange fluorescence.....

*B. DILUTE AQUEOUS SOLUTION NOT FLUORESCENT.* Add to solution of color a few drops of tannin reagent.

- a.* No precipitate of color. Apply double dyeing test of Sostegni and Carpentieri (Bul. 107, revised, p. 190). [If, in course of test, fiber or solution becomes purple on addition of  $NH_4OH$ , test directly for *cochineal* by Robin's test (Bul. 107, revised, p. 200) or *lichen colors* by Tolman's method (*J. Amer. Chem. Soc.*, 1905, p. 213).]
- 1. Fiber dyed. Make 0.01 per cent aqueous solution alkaline with  $NH_4OH$  and extract with amyl alcohol.

a. Considerable color extracted by amyl alcohol, which is colored red. Shake color solution, acidified with HCl, with ether.

x. Considerable color passes into ether layer.

1a. Aqueous layer colorless; ether layer yellow..... *Erythrosin* (S. & J. 517)  
 [Rose Bengal solution is pink; erythrosin is red orange. Can only be distinguished with certainty by testing for or determining both chlorin and iodin in the color, carefully purified by extraction with ether from acidified solution.]

2a. Aqueous layer remains red; ether layer orange or red. To aqueous solution add ammonia. Brownish-yellow solution..... *Azo eosin* (S. & J. 71)  
 No change.

Aqueous solution of color orange red; + HCl, yellow-brown precipitate. *Fast red A* (S. & J. 102)

y. Color not extracted by ether. Make solution alkaline with  $\text{NH}_4\text{OH}$  and shake again.

1a. Color passes into ether layer, which is colorless..... *Magenta* (S. & J. 448)

2a. Color does not dissolve in ether layer. Extract acid solution with acetic ether.

1b. Considerable color extracted. Treat dyed fiber with concentrated HCl.

1c. Fiber colored crimson. Dissolve in neutral amyl alcohol. Fluorescent..... *Azo eosin* (S. & J. 71)

Not fluorescent..... *Archil substitute 3VN* (S. & J. 29)

2c. Fiber colored yellowish. Dissolve in neutral acetic ether. Fluorescent..... *Archil substitute* (S. & J. 28)

2b. No color extracted. Treat dyed fiber with concentrated HCl.

1c. Fiber colored blue. To dyed fiber add NaOH solution. Fluorescent..... *Erythrosin*

1d. Fiber crimson. To 10 cc aqueous solution add 5 drops HCl.

No change..... *Ponceau 4RB* (S. & J. 160)

Dark blue and precipitate..... *Benzopurpurine* (S. & J. 277 or 278)

2d. Fiber brown or brown violet. To dyed fiber add concentrated  $\text{H}_2\text{SO}_4$  = green, *Fast Ponceau B* (S. & J. 163)

2c. Fiber colored magenta..... *Fast red B* (S. & J. 65)

## IV. RED COLORS—Continued.

## I. Soluble in cold water—Continued.

## B. DILUTE AQUEOUS SOLUTION NOT FLUORESCENT—Continued.

a. No precipitate of color—Continued.

1. Fiber dyed—Continued.

β. Almost no color extracted. Treat dyed fiber with concentrated HCl.

1a. Crimson or scarlet. To dry color add concentrated  $H_2SO_4$ .

1b. Purple or violet. Acidify aqueous color solution with HCl and shake with amyl alcohol.

1c. No color extracted. To aqueous solution add NaOH solution.

2. Dirty yellow solution—Dry color is yellow-brown..... Ponceau 6R (S. &amp; J. 108)

Darker red solution—Dry color is brownish-red..... Amaranth (S. &amp; J. 107)

2c. Much color extracted—Amyl alcohol layer scarlet..... Fast red C (S. &amp; J. 103)

2b. Crimson or scarlet. Note color of neutral aqueous solution (0.01 per cent).

1c. Orange red. To 0.01 per cent aqueous solution add 10 per cent  $BaCl_2$  solution.1d. Crimson precipitate. To aqueous solution add 10 per cent  $FeCl_3$  solution.

Orange precipitate.....

2d. No precipitate. Saturate aqueous solution with salt and extract with equal

volume of neutral acetone.

Acetone extracts almost no color..... Cochineal red A (S. &amp; J. 106)

Acetone layer extracts considerable color and is orange,

2c. Crimson or magenta..... Brilliant cochineal 2R (S. &amp; J. 53)

2a. Nearly or quite decolorized..... Lane fuchsine (S. &amp; J. 462)

(See also Girard's and Bellier's tests, Bul. 107, revised, p. 193, and Girard and Dupré, Analyse des matières alimentaires, p. 169.)

3a. Purple.....

4a. Blue. To dry color add concentrated  $H_2SO_4$ .

1b. Magenta solution..... Biebrich brilliant crocín scarlet (S. &amp; J. 146)

2b. Blue solution. To dyed fiber add NaOH solution.

1c. Fiber purple..... Biebrich fast scarlet (S. &amp; J. 159)

|  |  |
|--|--|
| 2c. Fiber brown. To aqueous solution add lead subacetate solution.   | <i>Crocēin scarlet 3B</i> (S. & J. 160)    |
| 1d. Yellow solution; orange precipitate.....   | <i>Crocēin scarlet 3B</i> (S. & J. 160)    |
| 2d. Pink solution; red precipitate.....  | <i>Crocēin scarlet 7B</i> (S. & J. 169)    |
| 2. Fiber not dyed. Dye wool, mordanted with alum, in aqueous color solution.   |  |
| α. Wool colored bluish or grayish violet.....  | <i>Logwood</i> (S. & J. 702)               |
| β. Wool colored bright red.....  | <i>Brazil wood</i> (S. & J. 701)           |
| 2. Colored precipitate. Dissolve color in ethyl or amyl alcohol and also in acetone.   |  |
| 1. Solutions fluorescent. To dyed fiber add 10 per cent NaOH solution = crimson.....   | <i>Saframine</i> (S. & J. 584)             |
| 2. Solutions not fluorescent. To dyed fiber add 10 per cent NaOH solution = decolorized.....   | <i>Magenta</i> (S. & J. 448)               |
| <b>II. Insoluble in cold water.</b>  |  |
| A. To alcoholic solution add $\text{NH}_4\text{OH}$ = blue.....  | <i>Alconin</i>                             |
| B. To dry color add concentrated $\text{H}_2\text{SO}_4$ .   |  |
| 1. Greenish-blue solution.....   | <i>Sudan III</i> (S. & J. 143)             |
| 2. Crimson solution.....   | <i>Sudan II</i> (S. & J. 49)               |
| 3. Fluorescent brown-yellow solution.....  | <i>Brazil wood</i> (S. & J. 701)           |
| C. Color dissolves in alkalies, forming orange solution (cotton immersed in alkaline solution is dyed red on acidifying).....                          | <i>Carthamine</i>                          |
| D. Nearly insoluble even in hot water, soluble in dilute alkali with brown-red color; completely precipitated, on acidifying, in red-brown flakes..... | <i>Barwood or sandalwood</i> (S. & J. 705) |







